Giga-tronics
INCORPORATED

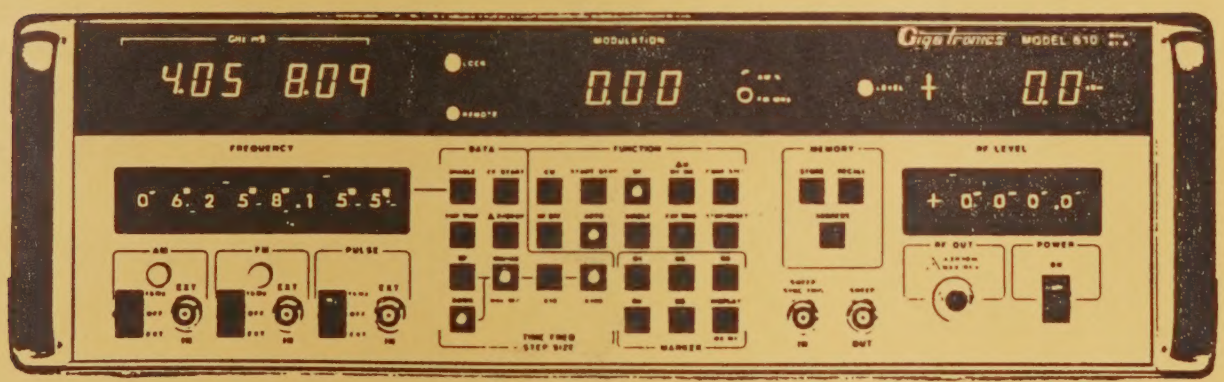
TM 09115A-14/1

OPERATION & MAINTENANCE MANUAL

MODEL 610

SWEEPING MICROWAVE

SYNTHESIZED SIGNAL GENERATOR



This manual applies to all Series 610 instruments. For information regarding instrument configuration and options, see page iii.

Shipping Assembly Part Number: see page iii.

Manual Part Number: 309AM01800

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WARRANTY

All Giga-tronics instruments are warranted against defective materials and workmanship for one year from date of shipment. Giga-tronics will at its option repair or replace products that are proven defective during the warranty period.

This warranty DOES NOT cover damage resulting from improper use, nor workmanship other than Giga-tronics service.

There is no implied warranty of fitness for a particular purpose, nor is Giga-tronics liable for any consequential damages.

Specification and price change privileges are reserved by Giga-tronics.

NOTES REGARDING THE TEXT

This manual employs the convention of indicating exponents by a capital 'E' (for example, 10E4 = 10000, and 6 X 10E-3 = .006).

Block diagram symbols used in the manual are defined at the beginning of Section Three.

SERIES 610 CONFIGURATION DATA

SHIPPING ASSEMBLY NUMBERS

This operation and maintenance manual is valid for all Series 610 instruments. The instruments in the series differ primarily in their frequency ranges, which are indicated by a suffix in the model number. Each instrument contains a frequency assembly appropriate to its frequency range. For instruments which include the .01-2 GHz range, see the Special Configurations Section (section 9).

Model	Shipping Assembly	Frequency Assembly	Test Assembly
610/2-8	309DA00700	304CA08600	309DA00800
610/6-12	309DA00701	304CA08603	309DA00800
610/10-18	309DA00702	304CA08602	309DAC0800
610/.01-8	309DA00703	304CA08604	309DA00800
610/.01-8, Config 117 (USMC)	309DA00704	304CA08604	309DA00801

OPTIONS, SPECIAL CONFIGURATIONS, MODIFICATIONS

Consult the "Config." line on the Model/Serial/Config. sticker affixed to the rear panel of the instrument. If this line is blank, there are no options installed in the instrument. If the line contains one or more two digit numbers (e.g., '06') the standard options corresponding to those numbers are installed in the instrument. Information concerning them will be found in Section 8 of this manual.

If the "Config." line of the Model/Serial/Config. sticker contains a three digit number (e.g., '052') there is a combination of standard or special options, and/or special modifications, installed in the instrument. Information concerning this will be found in Section 09 of the instrument.

Instruments that include the downconverter range (.01-2 GHz) require modifications described in section 9.1 of this manual.

SERIAL NUMBERS

This instrument has a six digit serial number. The first two digits are a prefix indicating instrument type (single band signal generators, including the 610 series, are signified by the following prefixes: 41, 42, 43, 44, 45, 46, 47, 48, 49, 60, 61, and 62). The last four digits of the serial number are a sequential suffix.

MANUAL CHANGES

Differences may exist between the manual and the instrument for which it is supplied, owing to printing errors or circuit changes. These differences are described in Section 10, with reference to individual instruments by serial number.

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GENERAL INFORMATION

In addition to the front matter presented here, this manual contains ten sections which describe various aspects of Series 610 synthesized microwave signal generators:

SECTION ONE -- Operating Information

This section is a user's guide to the instrument and its controls.

SECTION TWO -- Performance Specifications

The instrument's performance parameters are specified in this section.

SECTION THREE -- Theory of Operation

This section provides a description (at the block diagram level) of the Series 610 and its method of operation, offered as an aid to understanding for the purpose of maintenance and applications.

SECTION FOUR -- Calibration and Testing

Procedures for inspection, calibration, and performance testing are outlined in this section.

SECTION FIVE -- Maintenance

This section presents step-by-step procedures for maintenance and troubleshooting.

SECTION SIX -- Parts Lists

This section provides complete lists of all parts and their sources.

SECTION SEVEN -- Diagrams

This section provides schematic diagrams, descriptions, and parts placement diagrams for all circuits.

SECTION EIGHT -- Options

This section describes options available for the Series 610.

SECTION NINE -- Special Configurations

This section describes special modifications, if any, that are applicable to this instrument.

SECTION TEN -- Manual Changes

This section contains errata information, and notations of any changes made to the instrument since the printing of the manual.

INTRODUCTION

Purpose and Function

The purpose and function of Series 610 instruments is to synthesize a range of microwave frequencies (fixed or swept) at a variety of power levels and in a variety of modulation modes.

Capabilities

The Series 610 is capable of generating output signals in one of four frequency ranges, depending on instrument configuration (.01-8, 2-8, 5.4-12.5 or 10-18 GHz) with output power levels from +10 to -119 dBm. The RF output can be swept through a range of frequencies, and can be internally or externally modulated in AM, FM and pulse modulation modes.

Performance Characteristics

The Series 610 generates its output signals under manual control, or under remote computer control via the IEEE-488 General Purpose Interface Bus. Complete performance specifications are given in Section 2 of this manual.

Weight and Dimensions

The Series 610 has a weight of 45 lbs (nominal); the dimensions are 5.25 inches (height) by 16.75 inches (width) by 18 inches (depth).

Power Requirements

100/120/220/240 VAC $\pm$ 10%, 50-400 Hz, 225 W max.

Environmental Requirements

The Series 610 is type tested to MIL-T-28800C, Type III, Class 5, Style E, Color R for Navy shipboard, submarine, and shore applications, except as follows:

Non-operating temperature range is -40°C to +70°C.
Relative humidity is limited to 95% noncondensating.
Altitude and EMI requirements are not specified.
Warm-up time is 20 minutes.

Items Furnished

In addition to options and/or accessories specifically ordered, items furnished with the instrument are:

1 ea. - Operation and Maintenance Manual, Part No. 309AM01800
1 ea. - 6 ft. power cord
2 ea. - PC Extender Board
1 ea. - PC Card Extractor
1 set. - Test Data

Items Required

An IEEE-488 interface cable is needed for remote control operation. Appropriate RF output cabling (made to fit the female type N output connector) can be ordered in the form of Accessory A001 (Cable Kit).

Tools and Test Equipment

No special tools are required to operate the Series 610; signal sources used for external modulation should meet the parameters set out in Section 2 of this manual. Test equipment required for calibration or performance verification is described in Section 4.

Storage

Storage of the instrument should be limited to an environment that does not exceed the temperature range of -40°C to +70°C.

Cooling

A cooling fan is installed in the instrument. The cooling air intake and exhaust are both located on the instrument's rear panel. Care must be taken to avoid obstructing the flow of air into and out of the instrument.

Cleaning

The air inlet screen should be cleaned whenever a significant amount of dirt or dust has accumulated. Whenever the instrument covers are removed, the interior should be blown out with low velocity dry air.

Installation and Preparation for Use

The instrument is shipped in an operational condition and no special installation procedures are required. A warm-up time of 20 minutes is recommended.

Receiving Inspection

When the instrument is received, check the carton for evidence of damage. If damage is found, notify the carrier immediately, and open the carton only in the carrier's presence.

Use care in removing the instrument from the carton and check immediately for evidence of shipping damage: loose or broken control knobs, bent or broken connectors, dents or scratches on the panels, etc.

Each Giga-tronics instrument must pass rigorous inspections and tests prior to shipment. Upon receipt, it should immediately be subjected to a performance check to insure that its operation has not been impaired during shipment. The performance verification procedure is described in Section 4 of this manual.

Preparation for Reshipment

To protect the instrument during reshipment, use the best packaging materials available. If possible, re-use the original shipping container. If this is not possible, a strong carton (350 lbs/in^2 bursting strength) or a wooden box should be used.

Wrap the instrument in heavy paper or plastic before placing it in the shipping container. Completely fill the areas on all sides of the instrument with packaging material, taking extra precautions to protect the front and rear panels.

Seal the package with strong tape or metal bands. Mark the outside of the package "FRAGILE -- DELICATE INSTRUMENT".

If corresponding with the factory or local Giga-tronics sales office regarding reshipment, please reference the full model number and serial number. If the instrument is being reshipped for repair, be sure to enclose all available pertinent data regarding the problem that has been found.

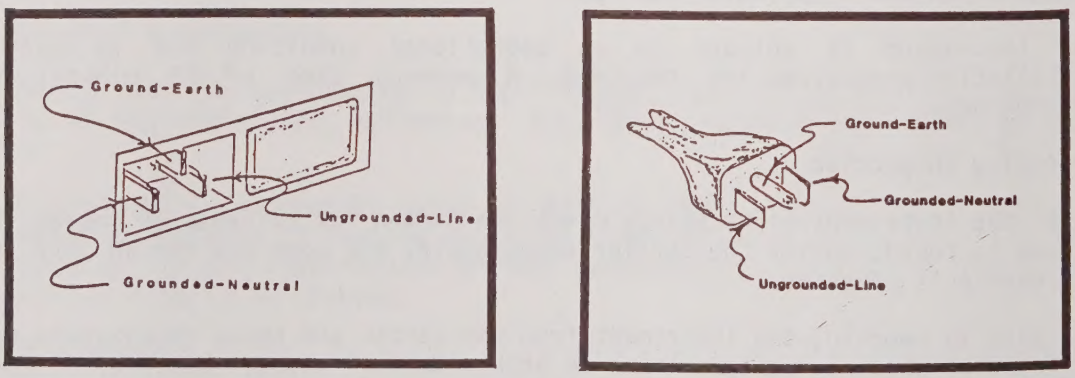


Figure 0.1: Power Line Connection

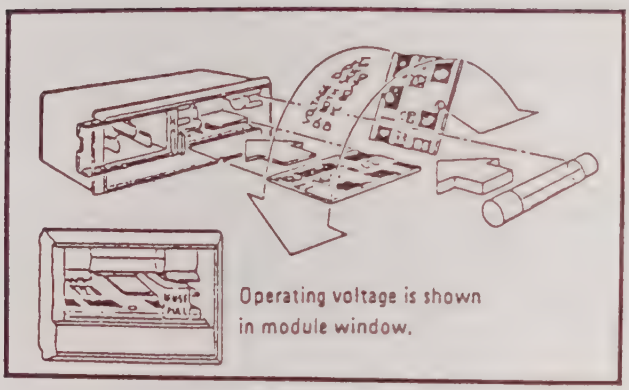


Figure 0.2: Voltage Selector/Fuse Holder

Safety Precautions

C A U T I O N

The instrument can be damaged if operated with the line voltage selector set inappropriately for the applied line voltage. Before operating the instrument, make sure that the instrument power requirements are compatible with the power source to be used. The instrument has been designed for international use over a broad range of voltages: 100, 120, 220, or 240, ± 10%, at 50-400 Hz. The Series 610 uses an internationally approved connector that includes voltage selection, fuse, and filter for RFI protection.

W A R N I N G

The instrument has a 3-wire power cord with a 3-terminal polarized plug for connection to the power source and safety-ground. The ground or safety ground is connected directly to the chassis; therefore, if a 3-to-2 wire adapter is used, be sure to connect the ground lead from the adapter to earth ground. Failure to do this could cause the instrument to float above earth ground, posing a shock hazard.

Voltage Selection

To select the correct operating line voltage, proceed as follows:

Open the cover door and rotate the fuse-pull to the left; remove fuse. Select the operating voltage by orienting the PC board in order to position the desired voltage label on the top left side. Push the board firmly into the module slot.

Rotate the fuse-pull back into the normal position and reinsert the fuse into the holder, using care to select the correct fuse value.

Fuse Selection

When the instrument is shipped from the factory, it is set for a particular power line voltage (normally 120V for domestic shipping destinations). The power line fuse for this setting is a 2.0A 3AG Slo-Blo. If the instrument is set to operate on a 240V power line, the fuse must be changed to a 1.0A 3AG Slo-Blo.

OPERATING INFORMATION

1.1 THE FRONT PANEL

The instrument's major controls and connections are located on the front panel and are illustrated in Figure 1.1; the various functional sections of the front panel are described below.

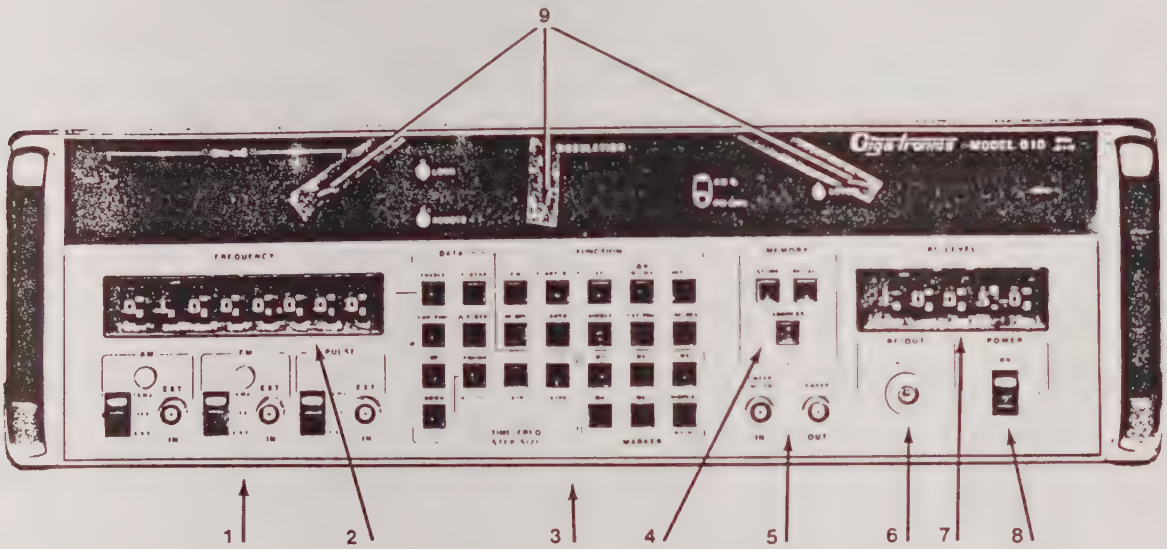


Figure 1.1: Model 610 Front Panel

1. Modulation Controls
2. Frequency Switches
3. Sweep/Generate Modes
4. Memory
5. Sweep Interface
6. RF Out
7. RF Level Switches
8. Line Power
9. Displays (Frequency, Modulation Meter, RF Level)

1.1.1 Amplitude Modulation

AM SWITCH (3-position switch) -- This control is used to select the desired AM mode:

1 kHz -- Selects internal AM with a fixed 1 kHz sine modulation waveform.
OFF -- Turns amplitude modulation off.
EXT -- Selects external AM.

AM VERNIER (knob) -- This control is used to adjust AM depth in both internal and external modes.

EXT IN (BNC connector) -- Accepts an external modulation signal for use in amplitude modulation.

1.1.2 Frequency Modulation

FM SWITCH (3-position switch) -- This control is used to select the desired FM mode:

1 kHz -- Selects internal FM with a fixed 1 kHz triangular modulation waveform.
OFF -- Turns frequency modulation off.
EXT -- Selects external FM.

FM VERNIER (knob) -- This control is used to adjust FM deviation in both internal and external modes.

EXT IN (BNC connector) -- Accepts an external modulation signal for use in frequency modulation.

1.1.3 Pulse Modulation

PULSE SWITCH (3-position switch) -- This control is used to select the desired pulse modulation mode:

1 kHz -- Selects internal pulse modulation with a fixed 1 kHz square modulation waveform.
OFF -- Turns pulse modulation off.
EXT -- Selects external pulse modulation.

EXT IN (BNC connector) -- Accepts a TTL-level modulation input signal for use in pulse modulation.

1.1.4 Sweep/Generate Modes

FUNCTION (Pushbutton switches)

CW -- Selects the fixed-frequency generate mode (no sweeping).
START/STOP -- Selects a sweep mode in which the start and stop frequencies are entered directly.
CF -- Selects a sweep mode in which a center frequency and an offset frequency (sweep width) are entered.
Delta-M, M1/M3 -- Selects a sweep mode in which the start and stop frequencies are defined by markers 1 and 3.
CONT/STEP -- Selects analog sweep mode (CONT) or digital sweep mode (STEP).

RF OFF -- Shuts off the RF output.
AUTO -- Causes the instrument to sweep repetitively, recycling at the end of every sweep.
SINGLE -- Initiates a single sweep.
EXT TRIG -- Enables a single sweep upon receipt of a trigger signal at the 'SWEEP SYNC TRIG IN' connector.
STOP/RESET -- In the analog sweep mode ('CONT'), pressing this button causes the sweep to restart. In the digital sweep mode ('STEP'),

pressing this button arrests the sweep at the current frequency until the button is pressed again, causing a sweep restart, or until 'AUTO' or 'SINGLE' or 'EXT TRIG' is pressed, causing the sweep to continue.

DATA (Pushbutton switches)

ENABLE -- Activates the frequency leverwheel switches for data entry; otherwise, data entry is by means of the UP/DOWN buttons.
CF/START -- Press to select center or start frequency of sweep.
SWP TIME -- Press to select sweep time in msec; data entry is by means of UP/DOWN buttons only.
Delta-F/STOP -- Press to select offset frequency or stop frequency of sweep.

TIME/FREQ/STEP SIZE (Pushbutton switches)

UP, DOWN -- These buttons are for increasing or decreasing the value of entered data, in increments. Also, in digital ('STEP') sweep, these buttons may be used to select sweep direction.
kHz-mS/MHz-SEC -- Defines the units of entered data. In the first position, the unit is kHz (to set frequency) or milliseconds (to set sweep time); in the second position, the unit is MHz (to set frequency) or seconds (to set sweep time). NOTE: sweep time is defined as sweep duration in analog ('CONT') sweep mode, and as step duration in digital ('STEP') sweep mode.
X10, X100 -- These buttons increase the size of the 'UP' and 'DOWN' increments (see 'kHz-mS/MHz-SEC') by factors of ten and one hundred, respectively (or one thousand if depressed simultaneously).

MARKERS (Pushbutton switches)

M1, M2, M3, M4, M5 -- When any marker button is pressed, the frequency of the relevant marker is displayed and the marker activated; new frequency data may be entered using the leverwheel switches or the UP/DOWN buttons.
DISPLAY M3-M1 -- When this button is pressed, the frequency difference between the first and third markers is displayed in MHz.

1.1.5 Sweep Interface

SWEEP SYNC TRIG IN (BNC connector) -- Accepts an external trigger (TTL low) to activate a single sweep (or single step, following 'STOP' in digital ['STEP'] sweep mode).

SWEEP OUT (BNC connector) -- Provides a 0 to 10 volt ramp output proportional to progress between the sweep limits.

1.1.6 RF Output

RF OUT (type N connector) -- Provides the RF output over the entire frequency range of the instrument.

1.1.7 Line Power

POWER (switch) -- Used to switch the instrument's power supply on and off; when the switch is in the "off" position the transformer primary is disconnected from the AC source.

1.1.8 RF Level Switches

RF LEVEL (leverwheel switches) -- These switches are used to set the RF output level in increments of 0.1 dB. Note the '+/-' switch for setting positive or negative values. The level selection may be read on the RF level display.

1.1.9 Memory

STORE (pushbutton) -- When this button is pressed, the current frequency and sweep settings are saved at the memory location indicated (the ADDRESS button must be pressed first).

RECALL (pushbutton) -- When this button is pressed, the frequency and sweep settings are retrieved from the memory location indicated (the ADDRESS button must be pressed first).

ADDRESS (pushbutton) -- The nine memory locations are accessed by pressing this button repeatedly until the desired address number is shown on the frequency display (e.g., 'Addr 5'). Frequency and sweep settings may then be stored or recalled, using the appropriate pushbutton.

1.1.10 Displays

RF LEVEL READOUT (fluorescent display) -- This 5-digit display is used to indicate the RF output level selected.

LEVEL (LED) -- This indicator is lit when the instrument is leveled.

MODULATION READOUT (fluorescent display) -- This 4-digit display is used to indicate modulation depth in percent (AM mode) and to indicate deviation in MHz (FM mode).

AM/FM (switch) -- This lever switch is used to select the modulation display mode (AM depth or FM deviation).

LOCK (LED) -- This indicator is lit when the RF output is phase-locked to the internal or external master reference.

REMOTE (LED) -- This indicator lights when the instrument is under remote control, via the IEEE-488 interface.

FREQUENCY READOUT (fluorescent display) -- This 8-digit display is used to indicate the frequency of the RF output, to indicate the frequencies of sweep limits and markers, and to display other information (e.g., error messages).

1.1.11 Frequency Switches

FREQUENCY (leverwheel switches) -- These switches are used to select the frequency of the RF output in increments of 1 MHz (1 kHz for instruments with Option 03, 1 kHz Resolution).

1.2 THE REAR PANEL

The rear panel houses input and output connectors used to interface the instrument with other devices. The different functional sections are illustrated in Figure 1.2 and described below.

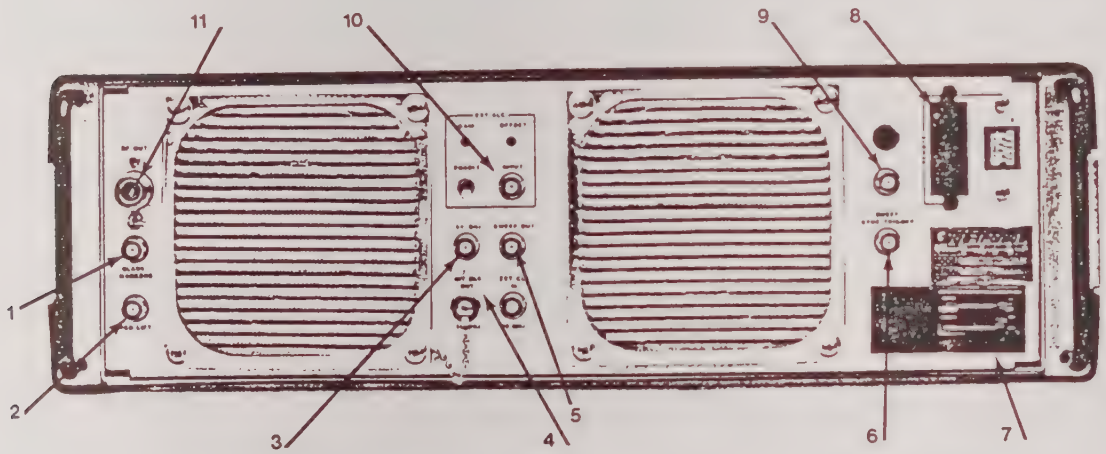


Figure 1.2: Model 610 Rear Panel

1. Blank/Markers
2. Pen Lift
3. .5V/GHz
4. Time Base In/Out
5. Sweep Out
6. Sweep Sync Trigger
7. Line Power
8. Remote Interface
9. Sweep Start Output
10. Ext ALC
11. RF Out (Option 22)

1.2.1 Rear Panel Descriptions

BLANK/MARKERS (BNC connector) -- Provides pulses coincident with the marker frequencies during an analog sweep; may be used to modulate the Z-axis input of an oscilloscope. The level of the marker pulse is -5 volts; the "unblank" (standard trace) level is 0 volts; the retrace level is +5 volts.

PEN LIFT (BNC connector) -- Provides a TTL low during retrace in digital ('STEP') sweep mode only; may be used to control a recorder pen or other data recording device.

.5V/GHz (BNC connector) -- Provides a voltage ramp output during an analog sweep that is directly proportional to output frequency; may be used to

control the horizontal position of an oscilloscope raster.

INT CLK OUT, 10 MHz (BNC connector) -- Provides a sample of the 10 MHz internal reference frequency, at 2 Vpp into 50 ohms.

EXT CLK IN, 10 MHz (BNC connector) -- Accepts an external 10 MHz reference input at 1 Vpp, which is automatically substituted for the internal reference frequency.

SWEEP OUT (BNC connector) -- An auxiliary connector which duplicates the front panel 'SWEEP OUT'.

SWEEP SYNC TRIGGER (BNC connector) -- An auxiliary connector which duplicates the front panel 'SWEEP SYNC TRIG IN'.

POWER INPUT (AC plug) -- A 3-terminal polarized connector with the safety ground wired to the chassis.

FUSE HOLDER & LINE SELECTION -- The line selector card can be oriented four ways to select four different line voltages: 100, 120, 220 and 240 volts. The power fuse should be a 2.0A 3AG Slo-Blo for 100/120 volt operation, or a 1.0A 3AG Slo-Blo for 220/240 volt operation.

REMOTE (24-pin connector) -- Provides an interface connection between the Model 610 and other equipment, in accordance with the GPIB IEEE-488-1978 format.

ADDRESS (5-place DIP switch) -- Used to set the GPIB address of the instrument in the form of a 5-bit binary number.

SWEEP START OUTPUT (BNC connector) -- This output produces a trigger pulse (TTL low) at the start of a sweep, which can be applied to the sweep sync trigger input of a second Model 610 for simultaneous synchronized sweeping.

EXT ALC (External Automatic Level Control)

ENABLE (switch) -- When this switch is in the enable position, the leveling system is programmed to ignore the instrument's internal detector and use instead an external detector input.

INPUT (BNC connector) -- Accepts an input signal from an external detector.

GAIN (potentiometer) -- This is used to adjust the instrument's leveling system to match the slope of an external detector's transfer curve (for calibration at the high end of the level range).

OFFSET (potentiometer) -- This is used to adjust the instrument's leveling system to match the intercept point of an external detector's transfer curve (for calibration at the low end of the level range).

RF OUT (type-N connector) -- In units with Option 22, the 'RF OUT' connector is relocated to the front panel.

1.3 FRONT PANEL OPERATION

The following part of section one provides step by step procedures for the various operating modes.

The basic function of series 610 instruments is to synthesize microwave signals within a given frequency range. Controls are provided to allow selection of frequency, output level, modulation mode, and sweep mode.

1.3.1 Error Messages

The instrument's computer system uses the frequency readout to display error messages when certain controls have been incorrectly set.

Error 1 -- Output frequency requested is out of range.
Error 2 -- Level requested is out of range.
Error 3 -- IEEE address switches on rear panel have been set to an invalid address of 31 (all ones).
Error 4 -- Sweep start frequency is greater than stop frequency.
Error 5 -- Sweep start frequency is out of range.
Error 6 -- Sweep stop frequency is out of range.
Error 7 -- CF/Delta frequency out of range.
Error 10 -- Illegal input command (remote operation).
Error 11 -- Illegal input number (remote operation).

1.3.2 Self Test

To initiate a lock and level test across the frequency range of the instrument, set the 10 GHz frequency leverswitch (the leftmost switch) to '9' ('CW' and 'ENABLE' must be activated also). The remainder of the frequency digits are used to specify the frequency increment of the test run; e.g., "90001" specifies a test run in increments of 1 MHz. The minimum step size is determined by the frequency resolution of the 610 (1 MHz in standard instruments, 1 kHz in instruments with Option 03). The test run repeats until it is deactivated (by setting the 10 GHz frequency switch to a digit other than '9'). The test run will halt at any frequency for which the instrument fails to lock or level.

1.3.3 RF Off

To shut down the RF output, depress the 'RF OFF' pushbutton so that it is illuminated. This disables the RF oscillator; no RF power is present at the output connector. In this mode the RF Level display shows dashes. To restore the RF output, press the 'RF OFF' button a second time.

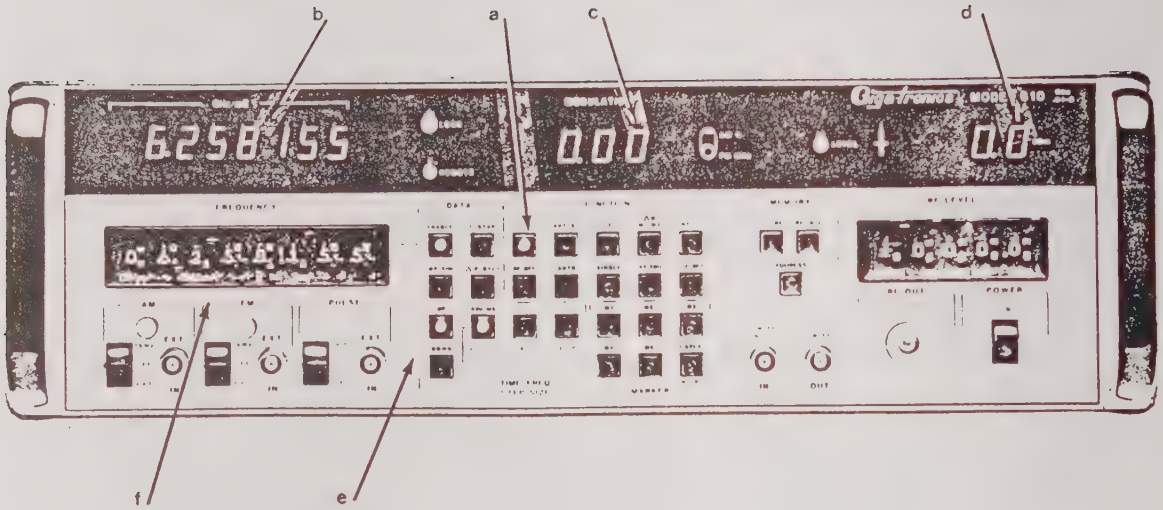


Figure 1.3: CW Mode

1.3.4 CW Mode

(See figure 1.3.) The instrument is initialized to the CW mode on power-up; the 'CW' pushbutton (see detail "a") is illuminated. The output frequency is displayed ("b") in GHz. Modulation (if any) is displayed ("c") in per cent or in MHz, depending on the position of the modulation meter switch. The output RF level is displayed ("d") in dBm. On power-up, the 'ENABLE', and 'UP' pushbuttons are activated, and the kHz-mS/MHz-SEC button is set to MHz-SEC ("e"). NOTE: The 'ENABLE' and 'UP/DOWN' buttons have no effect on level or modulation. Output power is set by the RF level switches, in dBm. Modulation is set by the AM, FM and PULSE controls.

In the CW mode, the output frequency may be set by means of the leverwheel switches ("f"), provided the 'ENABLE' button is lit.

To disable the leverwheel switches, (see figure 1.4) press 'UP' or 'DOWN' (see detail "a"); this will cause 'ENABLE' to go dark. The output frequency may then be incremented or decremented by pressing 'UP' or 'DOWN' as many times as necessary. The size of the frequency increment may be set by pressing the kHz-mS/MHz-SEC button ("b"). The button is lit for MHz-SEC. The increment may be multiplied by a factor of 10, 100, or 1000 by pressing the 'X10' or 'X100' buttons, or both (the pushbuttons are lit when activated.

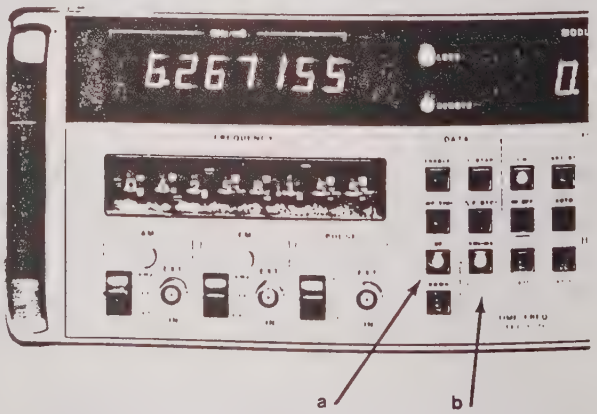


Figure 1.4: 'UP/DOWN' Data Entry

1.3.5 START/STOP Mode

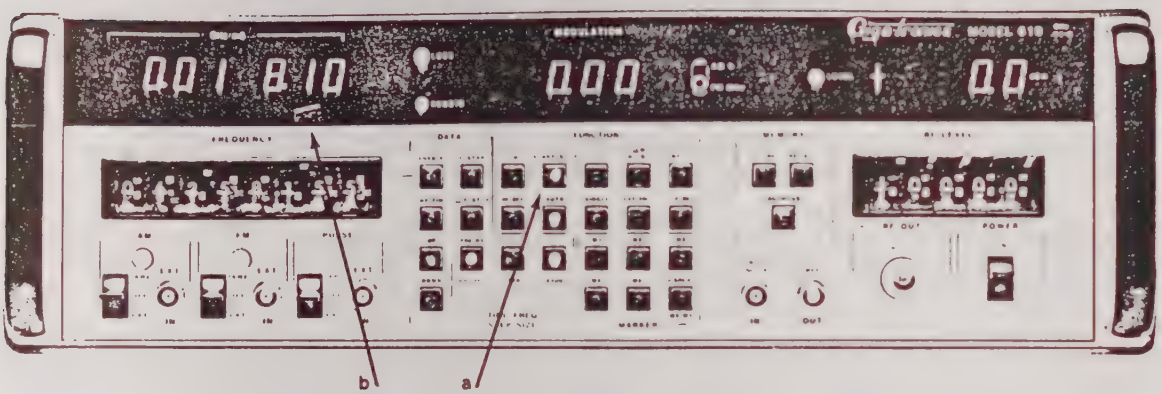


Figure 1.5: START/STOP Mode

(See figure 1.5.) The START/STOP mode creates a sweep between two specified frequencies. Press 'START/STOP' ("a"); the pushbutton is lit when active. Upon selection of this mode, there is a brief programming delay during which the message "prog." is shown on the frequency readout; after the delay, the sweep limits (start and stop frequencies, in GHz) appear in a split display on the frequency readout ("b"). The sweep function is initialized to 'AUTO' (automatic recycle sweep) and 'CONT' (analog sweep mode).

To set the start frequency (see figure 1.6) press 'CF/START' ("a"). The start frequency is displayed by itself, to maximum resolution. Set the start frequency by pressing 'ENABLE' ("b"), and using the leverwheel switches. Or, set the start frequency by pressing the 'UP' or 'DOWN' buttons as needed to achieve the desired frequency ("c"). The increment size for the UP and DOWN functions may be set using the 'kHz-mS/MHz-SEC' button and its multipliers ('X10', 'X100', or both for 1000). Press 'CF/START' again to begin the sweep with the new limits (the split display returns).

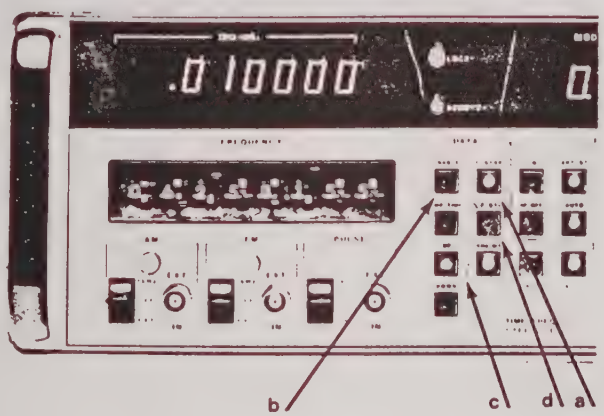


Figure 1.6: START and STOP Frequencies

To set the stop frequency, press 'Delta-F/STOP' ("d"). The stop frequency is displayed by itself, to maximum resolution. Set the stop frequency by the same means used to set the start frequency. To begin the sweep with the new limits, press 'Delta-F/STOP' again.

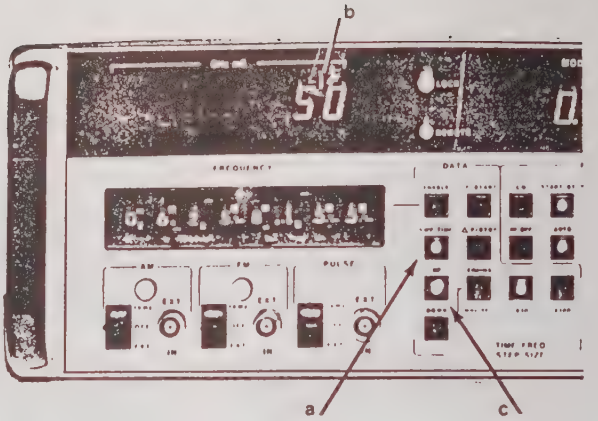


Figure 1.7: Sweep Time

To set the sweep time (see figure 1.7), press 'SWP TIME' ("a"). The time is displayed on the frequency readout ("b"), in milliseconds. Set the time using the UP/DOWN function ("c") and multipliers, not the leverwheel switches.

NOTE 1 -- In analog sweep ('CONT'), sweep time means the duration of a full sweep; in digital sweep, ('STEP'), sweep time means the duration of a sweep increment.

NOTE 2 -- In analog sweep ('CONT'), a limited number of sweep time intervals is available. The intervals, created by a binary divider, are in doubling sequence beginning with 10 msec (10, 20, 40, etc). The instrument's internal computer selects the interval that is closest to the sweep time requested by the operator (e.g., 320 msec for requested sweep time of 300 msec).

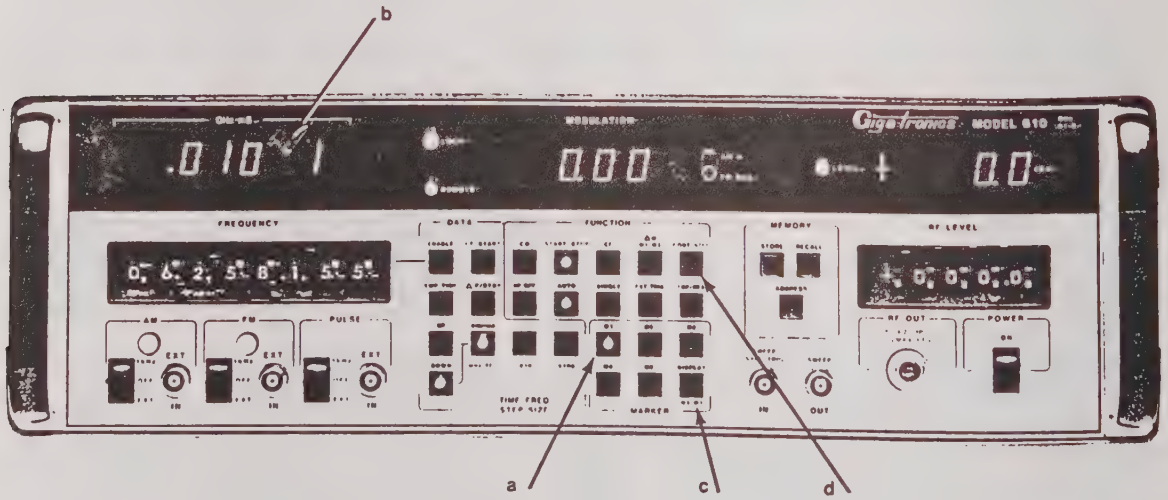


Figure 1.8: Marker Setting

(See figure 1.8.) To set a marker, press the associated marker button ("a"), so that the button is lit (each marker is activated so long as its pushbutton is lit; to deactivate a marker, press the button an extra time).

The frequency readout ("b") will show the frequency of the marker in GHz, followed by the marker number (e.g., ".010 1"). The frequency of the marker may be adjusted using 'ENABLE' and the leverwheel switches, or using the UP/DOWN function. When markers are being set, the 'UP' and 'DOWN' buttons increment automatically if held down, with the increment size increasing tenfold at the end of each decade. To set another marker, press the associated marker button. To return to the split display of sweep limits, press 'AUTO', 'SINGLE', or 'EXT TRIG'.

When 'DISPLAY/M3-M1' ("c") is pressed, the difference (in GHz) between the first and third marker frequencies is displayed on the frequency readout. To return to the previous display, press the button a second time.

Analog or digital sweep may be selected by pressing 'CONT/STEP' ("d"); the button is lit for digital sweep. In the digital sweep mode only, it is possible to reverse the direction of the sweep ("stop" to "start", resetting to the "stop" frequency) by pressing the 'DOWN' button. Also, in digital sweep mode only, the actual output frequency is displayed and continuously updated (in the analog sweep mode, the split display of sweep limits remains constant).

(See figure 1.9.) To select a sweep function ('AUTO', 'SINGLE', or 'EXT TRIG'), press the appropriate button so that it is lit. The 'AUTO' function produces automatic repeated sweeps. The 'SINGLE' function produces a single sweep each time the button is pressed (afterwards the frequency readout displays "hold" until the next sweep is inititated). The 'EXT TRIG' function produces a single sweep upon receipt of a pulse at the 'SWEEP SYNC TRIG IN' connector (afterwards the frequency readout displays "hold" until the next sweep is initiated).

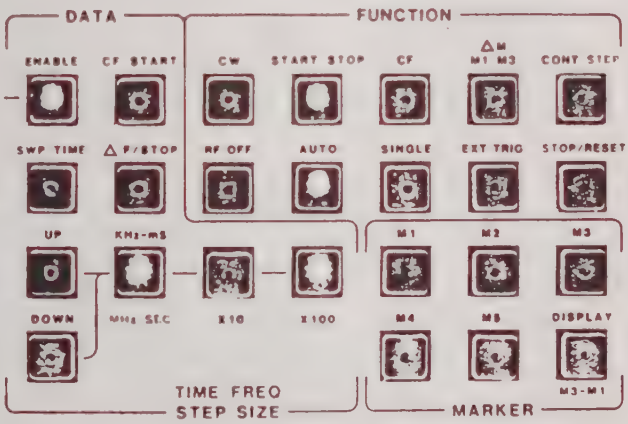


Figure: 1.9: Sweep Functions

The effect of pressing 'STOP/RESET' depends on other settings; during an analog sweep it causes a restart, and during a digital sweep it arrests the sweep at the current frequency until the button is pressed a second time, causing a restart, or until 'AUTO' or 'SINGLE' or 'EXT TRIG' is pressed, causing the sweep to continue. NOTE: in 'SINGLE' or 'EXT TRIG', a sweep restart means that the instrument waits for the sweep to be initiated, and displays "hold" in the meantime. In digital ('STEP') sweep mode only, single steps may be triggered following 'STOP' by pressing the 'UP' and 'DOWN' buttons, or, in 'EXT TRIG' mode, by applying a trigger input (set 'UP/DOWN' to determine the direction of change).

1.3.6 CF Mode

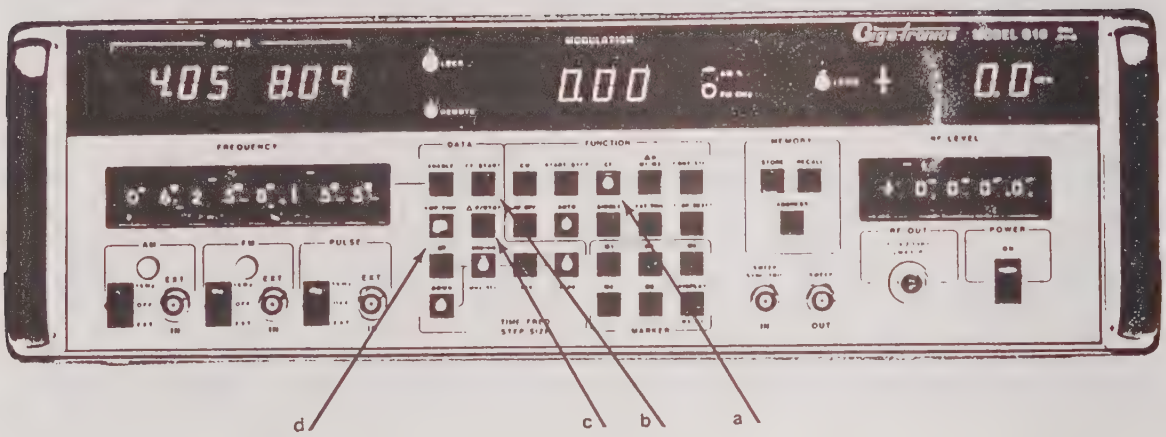


Figure 1.10: CF Mode

The CF mode creates a sweep between limits defined by a center frequency and an offset. Press 'CF' ("a"); the pushbutton is lit when active. Upon selection of this mode, there is a brief programming delay during which "prog." is displayed on the frequency readout; after the delay, the sweep limits (center frequency and sweep width, in GHz) appear in a split display on the frequency readout. The sweep function is initialized to 'AUTO' (automatic recycle sweep) and 'CONT' (analog sweep mode). Generally, data entry and control functions are similar to operation in the START/STOP mode.

To set the center frequency, press 'CF/START' ("b"). The center frequency is displayed by itself, to maximum resolution. Adjust the center frequency by pressing 'ENABLE', and using the leverwheel switches. Or, set the center frequency by pressing the 'UP' or 'DOWN' buttons as needed to achieve the desired frequency. The increment size for the UP and DOWN functions may be set using the 'kHz-mS/MHz-SEC' button and its multipliers ('X10', 'X100', or both for 1000). To return to the split display of sweep limits, press 'CF/START' again, so that the pushbutton is dark.

To set the offset frequency (which represents total sweep width), press 'Delta-F/STOP' ("c"). The offset frequency is displayed by itself, to maximum resolution. Set the offset frequency in the same manner used to set the center frequency. To return to the split display of sweep limits, press 'Delta-F/STOP' again.

To set the sweep time, press 'SWP TIME' ("d"). The time is displayed on the frequency readout, in milliseconds. Set the time using the UP/DOWN function and multipliers, not the leverwheel switches. NOTE: in analog sweep ('CONT'),

sweep time means actual sweep duration; in digital sweep ('STEP'), sweep time means the duration of a sweep increment. To return to the split display of sweep limits, press 'SWP TIME' again.

To set a marker, press the associated marker button, so that the button is lit (each marker is activated so long as its pushbutton is lit; to deactivate a marker, press the button an extra time). The frequency readout will show the frequency of the marker in GHz, followed by the marker number (e.g., ".010 1"). The frequency of the marker may be adjusted using 'ENABLE' and the leverwheel switches, or using the UP/DOWN function. When markers are being set, the 'UP' and 'DOWN' buttons increment automatically if held down, with the increment size increasing tenfold at the end of each decade. To set another marker, press the associated marker button. to return to the split display of sweep limits, press the button for the desired sweep function.

When 'DISPLAY/M3-M1' is pressed, the difference (in GHz) between the first and third marker frequencies is displayed on the frequency readout. To return to the previous display, press the button a second time.

Analog or digital sweep may be selected by pressing 'CONT/STEP'; the button is lit for digital sweep. In the digital sweep mode only, it is possible to reverse sweep direction (from high frequency to low, resetting to high) by pressing the 'DOWN' button. Also, in digital sweep only, the actual output frequency is displayed and continuously updated (in the analog sweep mode, the split display of sweep limits remains constant).

To select a sweep function ('AUTO', 'SINGLE', or 'EXT TRIG'), press the appropriate button so that it is lit. The 'AUTO' function produces automatic repeated sweeps. The 'SINGLE' function produces a single sweep each time the button is pressed (afterwards the frequency readout displays "hold" until the next sweep is initiated). The 'EXT TRIG' function produces a single sweep upon receipt of a pulse at the 'SWEEP SYNC TRIG IN' connector (afterwards the frequency readout displays "hold" until the next sweep is initiated).

The effect of pressing 'STOP/RESET' depends on other settings; during an analog sweep it causes a restart, and during a digital sweep it arrests the sweep at the current frequency until the button is pressed a second time, causing a restart. NOTE: in 'SINGLE' or 'EXT TRIG', a sweep restart means that the instrument waits for the sweep to be inititated, and displays "hold" in the meantime. In digital ('STEP') sweep mode only, single steps may be triggered following 'STOP' by pressing the 'UP' and 'DOWN' buttons, or, in 'EXT TRIG' mode, by applying the necessary input signal (with the direction of changed determined by the setting of the 'UP' and 'DOWN' buttons).

1.3.7 Delta-M Mode

Figure 1.11: Delta-M Mode

The Delta-M mode creates a sweep between the frequencies represented by the first and third markers. Upon selection of this mode ("a"), there is a brief programming delay during which the message "prog." is shown on the frequency readout; after the delay, the sweep limits (first and third marker frequencies, in GHz) appear in a split display on the frequency readout ("b"). The sweep function is initialized to 'AUTO' (automatic recycle sweep) and 'CONT' (analog sweep mode). Generally, data entry and control functions are similar to operation in the START/STOP mode.

To set a marker frequency, press the associated marker button, so that the button is lit (each marker is activated so long as its pushbutton is lit; to deactivate a marker, press the button an extra time). The frequency readout will show the frequency of the marker in GHz, followed by the marker number (e.g., ".010 1"). The frequency of the marker may be adjusted using 'ENABLE' and the leverwheel switches, or using the 'UP/DOWN' function. When markers are being set, the 'UP' and 'DOWN' buttons increment automatically if held down, with the increment size increasing tenfold at the end of each decade. To set another marker, press the associated marker button. To return to the split display of sweep limits, press the button for the desired sweep function.

When 'DISPLAY/M3-M1' ("c") is pressed, the difference (in GHz) between the first and third marker frequencies is displayed on the frequency readout. To return to the previous display, press the button a second time.

To set the sweep time, press 'SWP TIME'. The time is displayed on the frequency readout, in milliseconds. Set the time using the UP/DOWN function and multipliers, not the leverwheel switches. NOTE: in analog sweep ('CONT'),

sweep time means actual sweep duration; in digital sweep ('STEP'), sweep time means the duration of a sweep increment. To return to the split display of sweep limits, press 'SWP TIME' again.

Analog or digital sweep may be selected by pressing 'CONT/STEP'; the button is lit for digital sweep. In the digital sweep mode only, it is possible to reverse the direction of the sweep (from high frequency to low, resetting to high) by pressing the 'DOWN' button. Also, in digital sweep mode only, the actual output frequency is displayed and continuously updated (in the analog sweep mode, the split display of sweep limits remains constant).

To select a sweep function ('AUTO', 'SINGLE', or 'EXT TRIG'), press the appropriate button so that it is lit. The 'AUTO' function produces automatic repeated sweeps. The 'SINGLE' function produces a single sweep each time the button is pressed (afterwards the frequency readout displays "hold" until the next sweep is initiated). The 'EXT TRIG' function produces a single sweep upon receipt of a pulse at the 'SWEEP SYNC TRIG IN' connector (afterwards the frequency readout displays "hold" until the next sweep is initiated).

The effect of pressing 'STOP/RESET' depends on other settings; during an analog sweep it causes a restart, and during a digital sweep it arrests the sweep at the current frequency until the button is pressed a second time, causing a restart. NOTE: in 'SINGLE' or 'EXT TRIG', a sweep restart means that the instrument waits for the sweep to be initiated, and displays "hold" in the meantime. In digital ('STEP') sweep mode only, single steps may be triggered following 'STOP' by applying the necessary input signal (with the direction of change determined by the setting of the 'UP' and 'DOWN' buttons).

1.3.8 Sweep Auxiliary Outputs

While the instrument is sweeping, four outputs are generated which may be used to synchronize the operation of auxiliary devices:

A 0V to +10V ramp, with voltage proportional to progress through the sweep, is available at the 'SWEEP OUT' connector.

During digital sweep ('STEP') mode only, a TTL low output during sweep retrace is available at the 'PEN LIFT' connector on the rear panel.

During analog sweep ('CONT') only, a voltage ramp, with voltage directly proportional to output frequency, is available at the '.5V/GHz' connector on the rear panel.

During analog swep ('CONT') only, a pulsed output, suitable for driving an oscilloscope Z-axis input, is available at the 'UNBLANK/MARKERS' connector on the rear panel. The level of the marker pulse is -5 volts; the "unblank" (standard trace) level is 0 volts; the retrace level is +5 volts.

1.3.9 AM Mode

Internal and external amplitude modulation modes are available. To display modulation depth in percent, select 'AM%' on the modulation meter switch. Modulation depth may be adjusted using the AM vernier. If desired, amplitude modulation can be simultaneous with operation in the other modulation modes.

(See figure 1.13.) For internal AM, select '1 kHz' on the AM switch. This mode provides fixed 1 kHz modulation, produced by an internal signal generator.

For external AM, select 'EXT' on the AM switch and apply an external modulating signal at the AM 'EXT IN' connector.

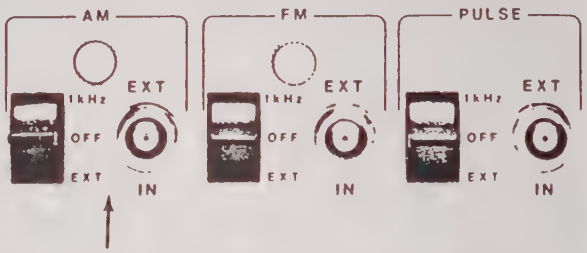


Figure 1.12: Amplitude Modulation

1.3.10 FM Mode

Internal and external frequency modulation modes are available. To display deviation in MHz, select 'FM MHz' on the modulation meter switch. Modulation depth may be adjusted using the FM vernier. If desired, frequency modulation can be simultaneous with operation in the other modulation modes.

(See figure 1.14.) For internal FM, select '1 kHz' on the FM switch. This mode provides fixed 1 kHz modulation, produced by an internal signal generator.

For external FM, select 'EXT' on the FM switch and apply an external modulating signal at the FM 'EXT IN' connector.

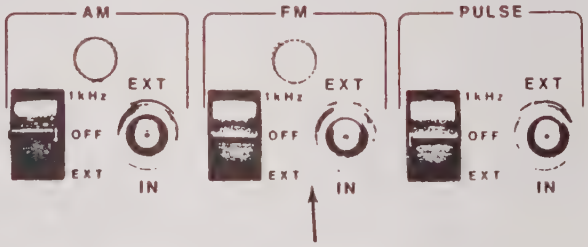


Figure 1.13: Frequency Modulation

1.3.11 Pulse Modulation Mode

Internal and external pulse modulation modes are available. If desired, pulse modulation can be simultaneous with operation in the other modulation modes.

(See figure 1.15.) For internal pulse modulation, select '1 kHz' on the PULSE switch. This mode provides fixed 1 kHz modulation, produced by an internal signal generator.

For external pulse modulation, select 'EXT' on the PULSE switch and apply an external modulating signal at the PULSE 'EXT IN' connector.

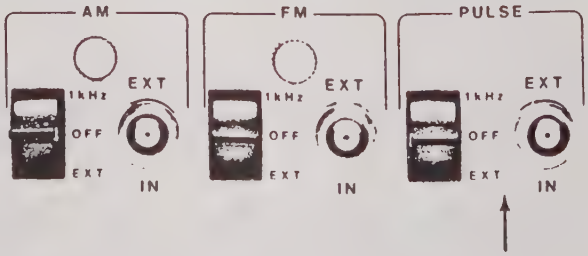


Figure 1.14: Pulse Modulation

1.3.12. Memory

The memory function is used to save front panel settings for later retrieval. A particular configuration of frequency, sweep, and output power control settings may be saved at each memory location.

(See figure 1.16.) The nine memory locations are accessed by pressing the 'ADDRESS' button repeatedly until the desired address number is displayed on the frequency readout (e.g., 'Addr 1', 'Addr 2' etc.). Control settings may then be stored at, or recalled from, the displayed memory location.

To save the present control settings at the displayed memory location, press the 'STORE' button. The frequency readout resumes its previous display.

To retrieve the control settings from the displayed memory location, press the 'RECALL' button. The frequency readout displays information appropriate to the new settings, including a programming delay ("prog.") in the case of a sweep setting which requires it.

Figure 1.15: Memory

1.4 REAR PANEL OPERATION

The following part of section one provides step by step operating procedures for functions implemented on the rear panel.

1.4.1 External ALC

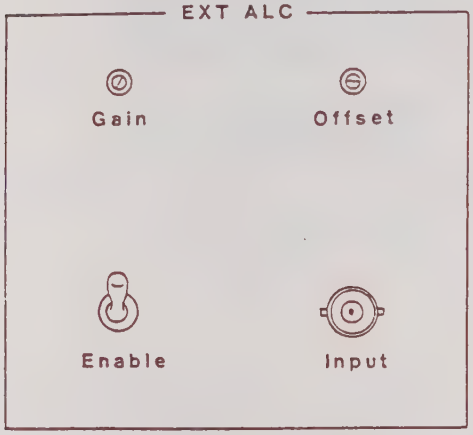


Figure 1.16: External ALC

The external ALC function provides remote leveling capability. The circuit is designed to operate with a directional coupler/diode detector having a standard negative output. Gain and offset adjustments permit calibration of the instrument to match individual detectors. Note that losses in the cable between the instrument RF output and the remote detector will place a limit on both maximum output and leveling range.

1. Connect the remote cable and detector to the instrument output. Connect the coupler/detector output to the rear panel 'EXT ALC' input.

2. Connect a power meter to the detector output and set the 'EXT ALC' switch to the "enable" position.

3. With the instrument's RF level set to 0 dBm, adjust the rear panel 'GAIN' to maximum (clockwise) and then adjust the rear panel 'OFFSET' for a power meter reading of 0 dBm (assuming the cable loss permits).

4. Set the RF level to -9 dBm and readjust 'OFFSET' for a power meter reading of -9 dBm.

5. Reset the RF level to 0 dBm and readjust 'GAIN' for a power meter reading of 0 dBm.

6. Repeat steps 4 and 5 as needed.

1.4.2 External Master Reference

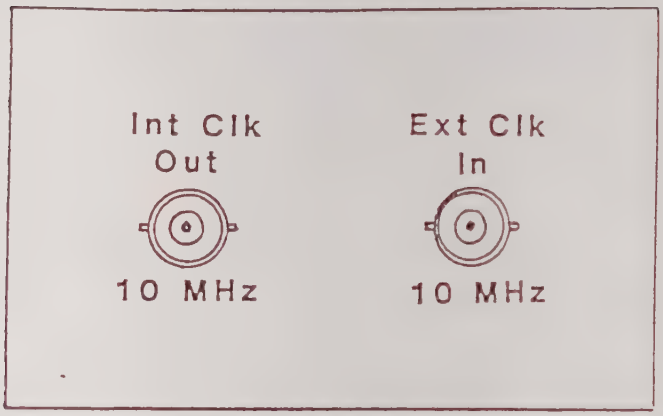


Figure 1.17 External master reference

The clock output provides a buffered 10 MHz signal derived from either the internal master reference or any external signal applied. This output will drive a 50 ohm olad to >1 Vpp.

The clock input accepts an external 10 MHz standard with an amplitude between .5 and 5 Vpp. The accuracy of the standard must be within 1 part per million to insure that the instrument will lock to it. The instrument will automatically switch to the external reference when a signal is present.

1.5 EXTERNAL PROGRAMMING (IEEE-488 INTERFACE)

Model 610 permits data bus control in accordance with the IEEE Standard Digital Interface for Programmable Instruments IEEE-STD 488-1978.

The following subsets of the standard are implemented:

SH1	Source Handshake	Complete Capability
AH1	Acceptor Handshake	Complete Capability
T8	Talker	Basic Talker, No Serial Poll No Talk Only, Unaddress if MLA
TE0	Extender Talker	No Capability
L4	Listener	Basic Listener, No Listen Only, Unaddressed if MTA
LE0	Extended Listener	No Capability
SR0	Service Request	No Capability
RL2	Remote/Local	No Local Lockout
PP0	Parallel Poll	No Capability
DC0	Device Clear	No Capability
DT0	Device Trigger	No Capability
C0	Controller	No Capability

1.5.1 IEEE-488 Hardware Configuration

INTERFACE CONNECTOR

The following table indicates the pin assignments for the rear panel 24 pin IEEE-488 interface connector.

Contact	Signal Line
1	D101
2	D102
3	D103
4	D104
5	E01
6	DAV
7	NRFD
8	NDAC
9	IFC
10	SRQ
11	ATN
12	Shield
13	D105
14	D106
15	D107
16	D108
17	REN
18	GND (6)
19	GND (7)
20	GND (8)
21	GND (9)
22	GND (10)
23	GND (11)
24	GND Logic

The contact assignments are those required by the IEEE-488 standard. Thus, most users need only connect a standard interface cable between their controller and the 610 interface connector.

ADDRESS ASSIGNMENT

The remote control address is assigned by the five small switches next to the interface connector. Switch 1 is the LSB; and switch 5 is the MSB. Thus, to assign the 610 an address of 6 (listen address '&' and talk address 'F'), the switches would be set as follows:

Switch number	1	2	3	4	5
Switch setting	0	1	1	0	0

SYNTAX CONFIGURATION

The standard remote control syntax (as described in this manual) is enabled by setting S7 on the CPU PC board (A4) to the on (up) position. S7's off position is reserved for enabling a special syntax which might be required in unusual applications. The instrument is normally shipped from the factory with S7 set to the on position.

1.5.2 General Command Structure

CHARACTER REPRESENTATION

In this manual, the ASCII characters sent in a message will be represented in single quotes.

e.g.: 'MESSAGE' corresponds to a string of seven bytes whose hexadecimal values are $4D, $45, $53, $53, $41, $47, $45.

Special characters will be represented as follows:

'<CR>'	Carriage return, $0D
'<LF>'	Line Feed, $0A
'b'	One or more spaces $20
'z'	Zero or more spaces
's'	One space
'd'	Decimal digit

COMMAND INTERPRETATION

The 610 uses a 40 character buffer to accept and store characters sent to it via the interface. Multiple sequential spaces are compressed to a single space character for storage in the buffer. The buffer's contents are interpreted and the buffer is reset upon receipt of a character sent with the EOI line asserted or upon receipt of any of the following delimiter characters:

'<CR>' '<LF>' ',' ':' ';' '/' '?' '\'

Multiple commands may be sent in a single message if they are separated from each other by a space or one of the above delimiter characters. If the commands are separated by spaces, they will not be interpreted until the entire message has been sent. (Note that if spaces are used to separate commands, care must be taken to assure that the 40 character buffer does not overflow: buffer overflow may cause some commands to be ignored.) If the commands are separated by delimiters, each command will be interpreted individually upon receipt. Unless the delimiter used is a carriage return, a potential problem exists when entering multiple commands separated by delimiters: if one of the commands is entered erroneously, it will be ignored and the correct commands accepted after only a momentary error display. The error message may not be displayed long enough to be read.

COMMAND FORMAT

Each command consists of a verb, followed by zero or more spaces, followed by an argument.

e.g.: 'AMzINT' AM is the verb and INT is the argument

'FAz6E+3' FA is the verb and 6E+3 is the argument

NUMERIC ARGUMENTS

Frequency and level setting commands use numeric arguments (represented in command descriptions as 'n'). The format for numeric arguments (described below) is sufficiently flexible that no special formating will be necessary when using most IEEE-488 controllers. Signed or unsigned numbers are acceptable. Integers or decimal fractions are permitted and may be followed by a signed or unsigned one or two digit exponent. Leading zeroes are permitted, but spaces within a number are not permitted. The integer and optional fractional part are each restricted to a maximum length of 10 digits.

The following are examples of valid numeric arguments:

'b25.7' / '-32.1' / '0.3' / '2958.763E-2'

'6E-10' / '-000.000000001E+10' / 'b7b' / '1E6'

1.5.3 Command Descriptions

Each subsection describes a verb and its valid arguments. Most commands perform functions in a way that is similar to the 610's front panel controls, except where noted.

'GEN' (set signal generation mode)

'GENzFIXED': generate fixed (CW) frequency
'GENzSTEPSS': digital sweep from FA to FB
'GENzSTEPCF': digital sweep centered on FA; delta = FB
'GENzSTEPDM': digital sweep from MA to MC
'GENzASWP': analog sweep from FA to FB
'GENzCSWP': analog sweep centered on FA; delta = FB
'GENzMSWP': analog sweep from MA to MC

(NOTE: Frequency designations are defined in section 1.5.4)

'AM' (set amplitude modulation mode)

'AMzOFF': amplitude modulation off
'AMzEXT': external AM
'AMzINT': internal AM, fixed 1 kHz sine wave (unless 'PANELzAM' is sent, depth defaults to PRESET value)

'FM' (set frequency modulation mode)

'FMzOFF':	frequency modulation off
'FMzEXT':	external FM
'FMzINT':	internal FM, fixed 1 kHz triangle wave (unless 'PANELzFM' is sent, deviation defaults to PRESET value)

'PULSE' (set pulse modulation mode)

'PULSEzOFF':	pulse modulation off
'PULSEzEXT':	external pulse mode
'PULSEzINT':	internal pulse modulation, 1 kHz square wave

'PANEL' (enable front panel modulation vernier)

'PANELzAM':	front panel AM vernier (depth) activated
'PANELzFM':	front panel FM vernier (deviation) activated

'PRESET' (enable preset potentiometer -- replaces front panel vernier)

'PRESETzAM':	preset AM depth pot activated
'PRESETzFM':	preset FM deviation pot activated

'EXTALC' (enable/disable external ALC)

'EXTALCzON':	Enables
'EXTALCzOFF':	Disables

'DISPLAY' (enable/disable front panel fluorescent displays)

'DISPLAYzON':	Enables	(NOTE: in the disabled mode, brackets at
'DISPLAYzOFF':	Disables	the left and right digits of the displays serve as a standby indication)

'RF' (enable/disable RF output)

'RFzON':	Enables
'RFzOFF':	Disables

'SWEEP' (set sweep function)

'SWEEPzAUTO':	automatic repetitive sweep
'SWEEPzONCE':	single sweep
'SWEEPzTRIG':	triggered single sweep (initiated by pulse at 'SWP SYNC TRIG IN' connector)
'SWEEPzRESET':	immediately terminates sweep (to restart, send the 'SWEEP' command for the function desired)

*'SWEEPzSTEPUP': single increment (step size equals FC)
*'SWEEPzSTEPDN': single decrement (step size equals FC)
*'SWEEPzSTOP': halts sweep at current frequency
*'SWEEPz+': sweep direction Fmin to Fmax
*'SWEEPz-': sweep direction Fmax to Fmin

*NOTE: Applicable only in digital ('STEP') sweep mode.

'SWPRATE' (set sweep time)

'SWPRATEzn': set sweep time to 'n' milliseconds

RANGE:
10 $\leq$ 'n' $\leq$ 100000

NOTE: sweep time represents sweep duration in analog ('CONT') sweep mode and step duration in digital ('STEP') sweep mode. For additional sweep time limitations see Note 2, page 1-10.

'STORE' (save present control settings)

'STOREzn': store control settings at memory location 'n'
('n' = 1, 2, 3, 4, 5, 6, 7, 8, or 9)

'RECALL' (retrieve control settings)

'RECALLzn': retrieve control settings from memory location 'n'
('n' = 1, 2, 3, 4, 5, 6, 7, 8, or 9)

1.5.4 Set Frequency Commands

Each frequency command requires a numeric argument, specifying the frequency in MHz. For instruments with Option 03 (1 kHz Resolution), up to three digits may be given to the right of the decimal, permitting the frequency to be specified to the nearest 1 kHz (e.g., 'n' = 4499.325 specifies 4.499325 GHz). Digits exceeding the frequency resolution of the instrument are ignored. In range specifications given with these commands, the following conventions are used to specify limits:

F min = minimum CW generate frequency
F max = maximum CW generate frequency

'FA' (set FA: fixed frequency, start frequency, or center frequency)

'FAzn': set FA to 'n'

RANGE:
F min $\leq$ 'n' $\leq$ F max (as fixed, start, or center frequency)
F min $\leq$ 'n' $<$ FB (as start frequency)

'FB' (set FB: stop frequency or offset frequency)

'FBzn': set FB to 'n'

RANGE:
'FAzn' < 'n' ≤ F max (as stop frequency)
'FAzn' - F min ≤ 'n' ≤ F max - 'FAzn' (as offset frequency)

'FC' (set frequency step)

'FCzn': set FC to 'n'

PERMITTED VALUES OF 'n':
1.0, 10, 100, 1000 (units with standard 1 MHz resolution)
0.001, 0.01, 0.1, 1.0, 10, 100, 1000 (units with option 03)

'MA', 'MB', 'MC', 'MD', 'ME', 'MF', 'MG', 'MH' (set markers 1 through 8)

'MAzn', 'MBzn', etc.: set appropriate marker frequency to 'n'

1.5.5 Set Level Command

The set level command requires a numeric argument, specifiying a level in dBm with .1 dB resolution. Digits specifying a finer resolution are rounded to the nearest .1 dB.

The 'LEVEL' command causes appropriate values for the step attenuator and leveling loop programming to be computed from the argument. The computation causes the step attenuator to switch at argument values which are evenly divisible by 10 (e.g., between '-29.9' and '-30.0).

'LEVELzn' (set output level to 'n')

The argument specifies the output level in dBm. Valid argument ranges are:

-119.9 ≤ 'n' ≤ +20.0

LEVELING LOOP RANGE LIMITATIONS

The leveling loop range is limited by the maximum output power which the instrument can produce. At very low levels, the on/off ratio of the instrument's PIN diode attenuators may also limit the loop's range. When the loop's dynamic range is exceeded, the front panel level light will go out.

'ERRORs2' will be issued upon receipt of invalid level command arguments.

1.5.6 Self-Test Command

This command causes the 610 to perform a lock/level test across its frequency range, in increments specified by a numeric argument. The frequency increment 'n' is in MHz. For instruments with Option 03 (1 kHz Resolution), up to three digits may be given to the right of the decimal, allowing the increment to be specified to the nearest 1 kHz. Digits exceeding the frequency resolution of the instrument are ignored.

'TESTzn' (perform self-test in steps of 'n' MHz)

1.5.7 Reply Messages

A reply message will be sent over the interface by the 610 whenever it is addressed to talk. If unaddressed in the middle of a message, any remaining characters are cleared from the output buffer. EOI is asserted during the last character ('<LF>') of each message. The type of message sent is determined by the 'SEND' commands described in the following subsections. If an error condition exists, a 'SENDzERROR' type message will be sent instead of the message type requested, except for 'SENDzNUL' which always returns a null line ('<CR><LF>').

'SENDzNUL' Send null line.

Message will be a null line ('<CR><LF>') even if an error condition is present.

'SENDzFREQ' Send frequency message.

The value sent always represents frequency in MHz.

'SENDzPOWER' Send power message.

The value sent represents power in dB or dBm, as appropriate, and is always signed as an integer in the following form: P INT ± xxx.x. If no valid power reading is available, the message is sent with 'n' = '-----'.

'SENDzSTATUS' Send status message.

The message sent is:
'sLOCKsdsLEVELsdsCALsd<CR><LF>'
where each 'd' is either '1' or '0' to represent true or false. 'LOCK' and 'LEVEL' are true when their corresponding front panel lights are on. 'CAL' is always zero.

'SENDzERROR' Send error message.

The message sent is <CR><LF> if no error exists. When an error condition does exist, the message sent is 'sERRORsdd', where 'dd' is the error code displayed on the front panel.

STATUS MESSAGE

The message normally sent is:
'sLOCKsdsLEVELsds<CR><LF>'
where each 'd' is either '1' or '0' to represent true or false. 'LOCK' and 'LEVEL' are true when their corresponding front panel lights are on.

ERROR MESSAGE

When an error condition exists, the message sent is 'sERRORsdd' where 'dd' is the error code displayed on the front panel. Individual error messages are as follows:

ERROR 1 -- requested fixed output frequency out of range
ERROR 2 -- requested level out of range
ERROR 3 -- generator set to illegal bus adress (all switches on)
ERROR 4 -- sweep start frequency greater than stop frequency
ERROR 5 -- requested start frequency out of range
ERROR 6 -- requested stop frequency out of range
ERROR 7 -- CF/Delta frequency out of range
ERROR 10 -- illegal input word (remote)
ERROR 11 -- illegal input number (remote)

1.5.8 Interface Initialization Values

The IEEE-488 interface is initialized upon assertion of IFC by the controller, upon instrument power up (CPU reset), and whenever the rear panel address switch settings are changed. The 610's remote control data are initialized to a "fixed frequency, no modulation" condition. Frequency and output level are initialized to the minimum values.

PERFORMANCE SPECIFICATIONS

Frequency Characteristics

FREQUENCY RANGE: indicated (in GHz) by model number suffix
(e.g., Model 610/2-8: 2 to 8 GHz)

FREQUENCY RESOLUTION: 1 MHz (standard)
1 kHz (instruments with option 03)

FREQUENCY ACCURACY/STABILITY: same as time base

INTERNAL TIME BASE FREQUENCY/ACCURACY: 10 MHz, ± 1 X 10E-6

INTERNAL TIME BASE STABILITY: <1 X 10E-6/year (standard)
<1 X 10E-9/day (with option 06)

EXTERNAL TIME BASE: 10 MHz, ± 1 X 10E-6 or better (overrides internal time base)

TIME BASE OUTPUT: buffered 10 MHz, 2 Vpp into 50 ohms (derived from internal or external time base)

Spectral Purity

HARMONICS, SUBHARMONICS: <-30 dBc, .01-2 GHz
<-40 dBc, >2 GHz

SPURIOUS (NON-HARMONICS): <-50 dBc, .01-2 GHz
<-55 dBc, >2 GHz

NOTE: Harmonic/subharmonic/spurious specification may degrade to -10 dBc (typ) above 5.3 GHz in Models 610/.01-12 and 610/2-12.

POWER LINE/FAN RELATED: <-45 dBc (typ)

SSB PHASE NOISE: <-75 dBc/Hz (typ) at 10 kHz offset, 1 Hz BW, CW mode

RESIDUAL FM (50 Hz - 15 kHz BW, CW MODE): <200 Hz, RMS

Output Characteristics

OUTPUT LEVEL RANGE: varies with frequency range; see table below:

RANGE	SPECIFICATION
2-8, 6-12, 10-18, .01-8, 1.8-7.5	-119 to +10 dBm
6-18	-119 to +3 dBm, (+5 dBm typ)
2-12	-119 to +6 dBm
.01-12	-119 to +4 dBm

OUTPUT LEVEL RESOLUTION: 0.1 dB

OUTPUT LEVEL ACCURACY: ± 2 dB

LEVEL FLATNESS: ± 1 dB

LEVEL DISPLAY FORMAT: 5-digit display; 0.1 dB resolution

OUTPUT IMPEDANCE: 50 ohms, nominal

OUTPUT CONNECTOR: type-N female

OUTPUT VSWR: <2:1

EXTERNAL ALC: Negative crystal detector; gain and offset adjustments provided

Analog Sweep Characteristics ('CONT' mode)

RANGE: selectable over entire frequency range

FUNCTION: automatic recycle or single sweep

MODE: start/stop (sweep limits defined by preset start and stop frequencies), CF (sweep limits defined by center frequency and offset frequency), or delta-M (sweep limits defined by preset markers)

SETTABILITY: sweep limits settable in 1 MHz increments (1 kHz with option 03)

ACCURACY (START/STOP): ± 30 MHz

LINEARITY: ± 5 MHz (after first 100 usec)

RESOLUTION: approximately 2 MHz for sweep widths >524 MHz
approximately 128 kHz for sweep widths <524 MHz

SWEEP TIME: settable from approximately 10 msec to 100 sec; maximum sweep rate is 600 MHz/msec

MARKERS: eight frequency markers (five settable via front panel), independently adjustable over entire frequency range)

BLANK/MARKER OUTPUT: composite signal for Z-axis modulation of an oscilloscope: 0 volts = unblanking
-5 volts = marker on
+5 volts = retrace (dark)

SWEEP SYNC TRIGGER INPUT: TTL-low to initiate a single sweep

SWEEP OUT: voltage ramp output, directly proportional to progress between sweep limits

.5V/GHz: voltage ramp output, directly proportional to frequency during an analog sweep

Digital Sweep Characteristics ('STEP' mode)

RANGE: selectable over entire frequency range

FUNCTION: automatic recycle or single sweep

MODE: start/stop (sweep limits defined by preset start and stop frequencies), CF (sweep limits defined by center frequency and offset frequency), or delta-M (sweep limits defined by preset marker frequencies)

NOTE: markers are non-function in digital sweep mode, but frequencies may be set for purposes of defining sweep limits

SETTABILITY: sweep limits settable in 1 MHz steps (1 kHz steps with option 03); sweep increments are 1, 10, 100 or 1000 MHz

SWEEP TIME: 10 msec/step to 100 sec/step

RAMP OUTPUT: 0 to 10 V, $\pm$ 10%, proportional to progress between sweep limits

SWEEP TRIGGER INPUT: TTL low to initiate single step or single sweep

PEN LIFT: TTL low during sweep retrace

Pulse Modulation Characteristics

INTERNAL: square wave, 1 kHz fixed rate

EXTERNAL: 10 Hz to 1 MHz rate

EXTERNAL INPUT: TTL pulses, positive level for RF on, width >50 nsec

RISE/FALL TIMES: <25 nanoseconds

SETTLING TIME: $\pm$ 1 dB within 100 nanoseconds

ON/OFF RATIO: >80 dB

OVERSHOOT/UNDERSHOOT/RINGING: +2 dB, max

SETTLING TIME (TO WITHIN 1 dB): <100 nsec

Amplitude Modulation Characteristics

INTERNAL: sine wave, 1 kHz fixed rate

EXTERNAL: rate 10 Hz to 10 kHz (100 kHz typ); sensitivity 1 Vpp for 50% modulation; distortion <10% (<5% typ) at 50% depth/1 kHz rate

DEPTH: 0 to 82%

INPUT IMPEDANCE: 600 ohms, BNC

DISPLAY: 3 digits; accuracy ± 10% at 1 kHz rate, 50% depth

Frequency Modulation Characteristics

INTERNAL: triangle wave, 1 kHz fixed rate

EXTERNAL: rate 10 Hz to 1 MHz; sensitivity ± 1.0 Vp for maximum deviation; distortion <5% at max deviation/500 kHz rate

DEVIATION: ± 5 MHz, peak

INPUT IMPEDANCE: 50 ohms (nominal), BNC

DISPLAY: 3 digits; accuracy ± 10% at 100 kHz rate, 3 MHz peak deviation

General

REMOTE INTERFACE: IEEE STD 488-1978

NON/VOLATILE STORE/RECALL: nine memory locations for front panel setups

WARM-UP TIME: 20 minutes, max

OPERATING TEMPERATURE RANGE: 0 to +50°C

ENVIRONMENTAL REQUIREMENTS: Type tested to MIL-T-28800C, type III, Class 5, Style E,

POWER: 100/120/220/240 VAC ± 10%, 50-400 Hz, 200 watts max

DIMENSIONS: 16.75" X 5.25" X 18"; 40 lbs nominal

CALIBRATION INTERVAL: 9 months

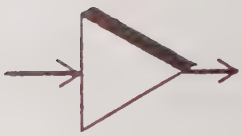
THEORY OF OPERATION

GLOSSARY OF SYMBOLS

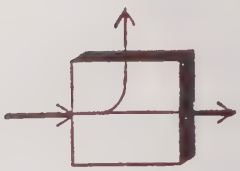
The following is a glossary of the block-diagram symbols used in this manual. Some of them are unusual figures devised to meet the special descriptive requirements of microwave synthesizers.

DIGITAL INFORMATION -- Data or instructions coded in binary form, used by the system computer to control the instrument and its various circuits.

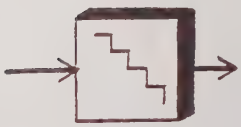
DIGITAL TO ANALOG CONVERTER -- A circuit which receives a binary number in digital code, and produces an output analog signal, the amplitude of which is proportional to the binary number.



AMPLIFIER/DRIVER/BUFFER -- A circuit which conditions the analog output of one circuit to make it compatible with the input requirements of another circuit.



COUPLER -- A device which, by induction, takes a sample of the signal passing through it for use in auxilliary circuits.

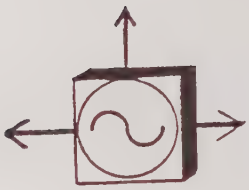


STEP-ATTENUATOR -- A programmable device which attenuates (reduces the power of) the signal passing through it by fixed increments.

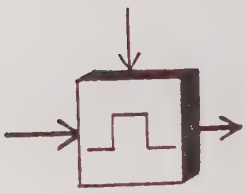
DETECTOR -- A device used to measure the power level of the RF signal applied to it. The detector produces a negative voltage proportional in amplitude to the detected power.

FREQUENCY DIVIDER -- A circuit which accepts a frequency input, and produces a frequency output equal to the input divided by some number.

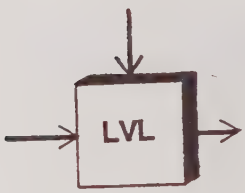
LOW-PASS FILTER -- A circuit designed to pass relatively low frequencies while suppressing relatively high frequencies; often used to block undesired harmonics.



MASTER REFERENCE -- The highly stable fixed 10 MHz signal to which all oscillators in the system are phase-locked. The standard timebase is a quartz oscillator built into the instrument; any external 10 MHz source can be substituted for it simply by connecting the source to the reference input.

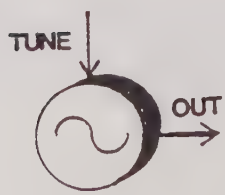


PULSE MODULATOR -- A PIN diode circuit used as a solid-state switch in order to turn the signal passing through it on and off; located inside the RF module.

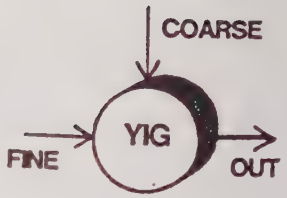


LEVELER -- A PIN diode circuit used as a variable attenuator in order to control the power of the signal passing through it; located inside the RF module.

MIXER -- A device which produces an "intermediate frequency" (IF) equal to the difference between its two input frequencies, or equal to the sum of its two input frequencies.



VOLTAGE CONTROLLED OSCILLATOR (VCO) -- An oscillator, the output frequency of which can be adjusted by means of a control voltage.



YIG-TUNED TRANSISTOR OSCILLATOR (YIG) -- A microwave frequency oscillator, named for its tuning element which is composed of Yttrium-Iron-Garnet. Coarse and fine frequency adjustment are performed by controlling the current through two tuning coils.

STEP-RECOVERY DIODE MULTIPLIER -- A device that produces an output signal rich in harmonic multiples of the input frequency.

PHASE DETECTOR -- A circuit which compares two frequency inputs (a fixed reference frequency and a variable frequency), determines the phase relationship between them, and generates output pulses having widths proportional to the degree of phase difference. The pulses appear at either of two outputs, depending on whether the variable input leads or lags the reference.

PHASE LOCK LOOP -- A circuit which combines a phase detector with a filter and amplifier. The filter and amplifier convert the phase detector pulse outputs into a control signal, which tunes the variable oscillator so that the phase difference between the two phase detector inputs is reduced.

GENERAL CONFIGURATION OF THE INSTRUMENT

Model 610 is a single-band sweeping microwave signal generator which employs a YIG oscillator, tuned by a phase lock loop system, to synthesize its RF output. All output frequencies are phase locked to a 10 MHz master reference, and may be selected in increments of 1 MHz (1 kHz for instruments with option 03). Output power is controlled by a leveling system, and may be selected in increments of 0.1 dB; a 10 dB step attenuator on the output is used to adjust the power in larger increments. The RF output may be internally or externally modulated (AM, FM, and pulse modulation modes). The instrument can be set to generate fixed frequencies or to progress through a range of frequencies in a variety of sweep modes. Remote operation is made possible by an IEEE-488 interface bus. All functions of the instrument are controlled by an internal computer.

Circuit boards A0 through A4 are plugged into the CPU bus board (A102) and constitute the internal computer. A5, also plugged into the CPU bus, is the level control board.

Circuit boards A6 through A13 are plugged into the RF bus board (A103); these are the high-frequency circuits used to synthesize the instrument's output signal, including the phase lock loops and the YIG driver. The RF bus board itself also houses the FM driver circuit. Circuit boards A9 and A10 are present only in instruments with option 03 (1 kHz Resolution).

The microwave deck includes the YIG oscillator, the RF module, the enclosed 300 MHz oscillator board (A104), the enclosed 110 MHz oscillator/multiplier board (A113), and the 10 dB step attenuator.

The modulation control board (A118) is located at the base of the front panel. The analog sweep boards (A24 through A27) are mounted behind, and parallel to, the front panel. The power supply is located behind and adjacent to the CPU bus.

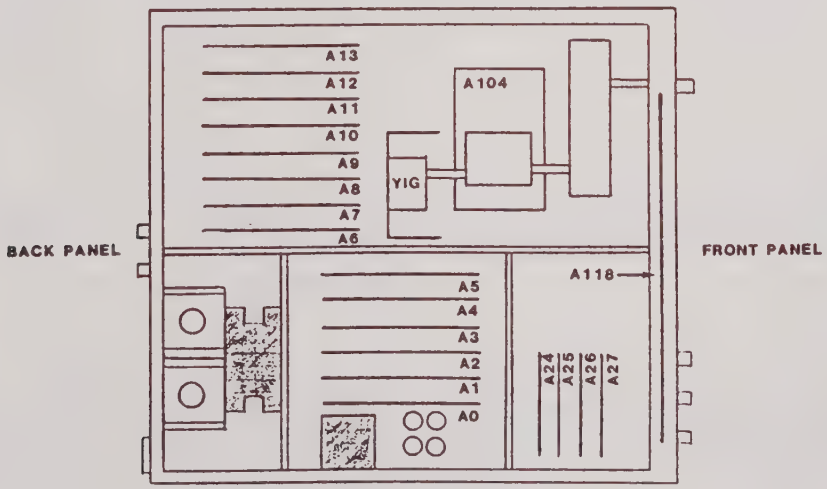


Figure 3.1: Series 610 Interior Layout

THE COMPUTER

An internal computer is used to control the Model 610. The computer is organized around a Motorola 6809 microprocessor with its internal clock controlled by a 3.579 MHz crystal. This clock frequency was selected to minimize beat notes generated by its harmonics and the various frequencies generated within the instrument.

The microprocessor controls, and communicates with, other circuits by means of Peripheral Interface Adapters or PIAs. These devices act as windows through which information and instructions are transmitted to and from the 6809's 8-bit data bus. The data bus is used to send control signals (including multiple-bit numbers in parallel) to the various functional sections of the instrument, and also to take in data from those locations. Digital/analog and analog/digital conversion are used by the computer in order to generate and measure analog signals.

The microprocessor's 16-bit address bus can access up to 64K of memory. Much of this memory capability is not presently used by the Model 610, so there remains room for expansion. Because control software can be rewritten more readily than control hardware can be rebuilt, Giga-tronics's memory-intensive approach has made this an extremely adaptable instrument.

Giga-tronics produces its own computer software, which is stored in PROM devices on the memory board (A2); also in that location are RAM devices used for temporary data storage. A "reset" PROM located on the CPU board itself (A4) contains initialization data, level characterization data, and other information unique to the individual instrument.

The microprocessor, the PIAs, and the semiconductor memory devices will be referred to collectively as the computer. The computer generates and receives digital data required for operation of almost every instrument function. It receives and interprets the operator's commands, through either the front panel switches or the remote interface; it returns information to the operator, through either the front panel displays or the remote interface; it selects appropriate reference frequencies, intermediate frequencies and divisors to generate the RF output; it tunes the YIG oscillator; it activates the appropriate harmonic filter line for the RF path; it controls the power level and the modulation of the RF output; it generates ramps and other control signals for use in frequency sweeping; it monitors the functioning of the instrument and supplies error messages and fault indicators to the operator.

THE RF PATH

Coupling, leveling, modulation, filtering, and attenuation of the output signal are accomplished in the path between the YIG oscillator and the instrument's RF output connector. Some power loss inevitably takes place in this RF path; Giga-tronics has cut this loss to a minimum, by using printed microstrip conductors and miniature components to create a hybrid circuit which incorporates most of the above functions into a single module. This clustering of RF circuits greatly reduces the power loss inherent in designs requiring multiple transitions and connectors.

Samples of the RF output signal are required by two circuits outside the RF path. Microstrip couplers located within the module are used to return portions of the RF signal to the output phase lock loop (by way of the sampling mixer) and to the level detector.

A leveler circuit within the module, consisting of PIN diodes, functions as a variable attenuator. A signal from the level control circuit regulates current through these diodes in order to adjust output power.

The output of a YIG oscillator is not spectrally pure. Harmonics of the fundamental frequency are usually present at amplitudes of -12 to -20 dBc. Low-pass filters (consisting of shaped microstrip elements) are used to eliminate these harmonics, and the path through the RF module is subdivided into either two or three filter lines, depending on output bandwidth. The switching of these paths is performed by PIN diode circuits, rather than by mechanical switches, for increased reliability.

The filter switch circuits are also used to pulse-modulate the RF output (the pulse modulation input is applied to the switch that controls the appropriate filter line). A second pulse modulation input is used to switch a 50 ohm termination into the RF path ahead of the filter switches during pulse "off" intervals. This is necessary because, during the "off" period, the RF path is opened and loses its output termination. If an additional termination were not switched into the circuit, reflected power would be picked up by the level coupler and would interfere with level control.

The output of the RF module is applied to the 10 dB step attenuator, which is connected directly to the front panel. Interconnections between components in the RF path are made through semi-rigid coaxial cable (waveguide is not required for the frequencies generated by instruments in the 610 series).

AMPLITUDE CONTROL

The output amplitude of the instrument is controlled by a combination of fixed-step attenuation and closed-loop leveling.

The output stage of the synthesizer consists of a step attenuator which provides up to 110 dB of attenuation in 10 dB increments. Finer control of the output level is provided by the closed loop leveling system, also referred to as Automatic Leveling Control or ALC.

The level control circuit is basically a loop amplifier with multiple inputs, of which one is feedback from the level detector, a device which returns a negative voltage proportional to the square of detected power. The RF measured by the detector is coupled from the output path by a circuit in the RF module (during operation in the external ALC mode, a remote detector is substituted for the internal one). The detector signal is amplified and applied to the summing junction of the leveling loop amplifier; it may be considered the "variable" input, in that it changes in response to the loop amplifier's output.

The "reference" input to the loop amplifier is a composite of three signals: a correction voltage from the temperature compensation circuit (A112), a

fixed leveling input which the system computer programs by means of a digital to analog converter, and the AM signal, if any, from the modulation generator board (A105). The AM signal is processed by a logarithmic amplifier to give it the same logarithmic characteristic as the other two inputs, so that all three can be combined by a summing amplifier. The combined signal is processed by an antilogarithmic amplifier on its way to the loop amplifier.

The loop amplifier output is applied to an amplifier which drives the PIN diode leveler in the RF module; the amplifier drives the leveler so as to balance the "reference" input against an equal and opposite "variable"

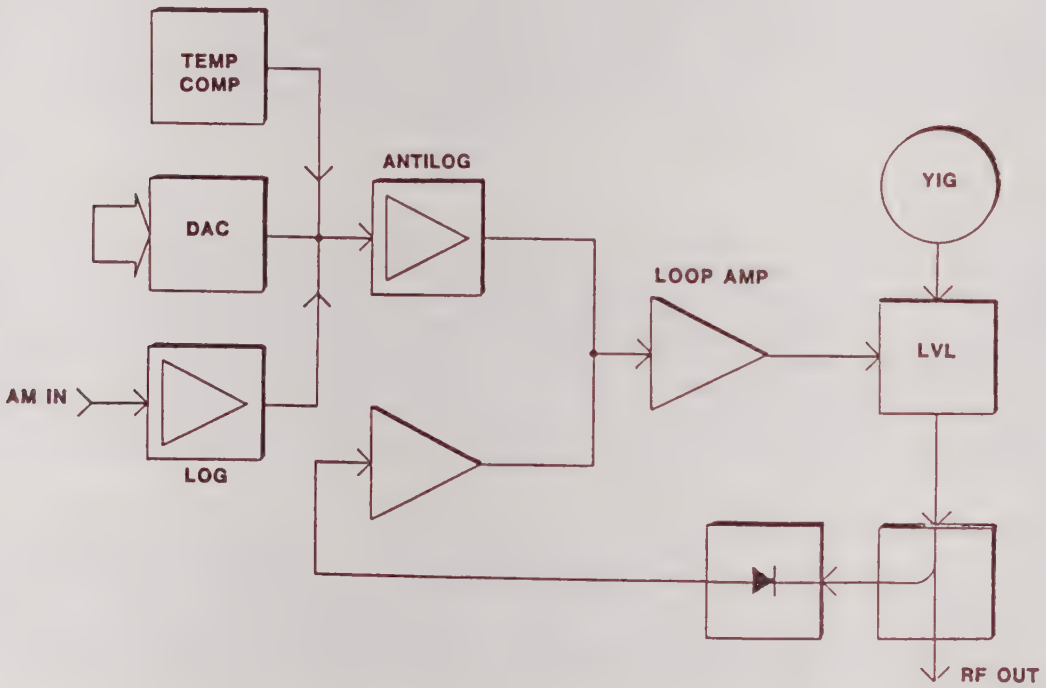


Figure 3.2: Amplitude Control

feedback input. In other words, the leveler adjusts RF power until the detector feedback input just cancels the other input to the loop amplifier.

In setting the leveling reference (through the programming of a digital to analog converter), the system computer includes compensation factors from a level-characterization table stored in the instrument's "reset" PROM (see A4). This data is individual to the instrument and is compiled during production testing.

During analog sweep operation, the standard level characterization system cannot be used because the access time of the computer's memory-read operation would limit the sweep rate; instead, a sweep level correction system is used which will be described in the discussion of analog sweep.

AMPLITUDE MODULATION

As described above, one component of the reference input to the loop amplifier in the level control circuit (A5) is an amplitude modulation input. This input comes from the modulation generator board (A105), where it is derived from the internal or external modulation signal. This board also houses the logic circuits by which the modulation mode is selected under either local or remote control, as well as the function generator used to produce internal modulation signals.

The AM input to the level control circuit (processed by a log amplifier to match it to the logarithmic characteristic of the computer's leveling reference and the temperature compensation input) supplies the leveling loop amplifier with a variable, rather than a fixed, leveling reference. The level control circuit furnishes a modulated control voltage to the leveler in the RF module in order to match the modulation of the reference. The result is an amplitude modulated RF output, with a modulation depth of up to 70%.

PULSE MODULATION

Pulse modulation is performed by means of path-switching circuits in the RF module. Depending on output bandwidth, there will be either two or three filter paths through the module, of which only one is active at a time. PIN diode circuits are used to switch these lines on and off; pulse modulation is accomplished by shutting off the active path intermittently (a positive voltage at the filter line's control pin on the outside of the module shuts the path off). By this method, an on/off ratio of greater than 80 dB can be achieved.

The drive signals used in pulse modulation originate on the modulation control board (A118), and are derived from the internal or external modulation signals by circuits which also furnish the sync and video outputs. The internal signal generator is located on this board, as are the logic circuits by which the modulation mode is selected under either local or remote control.

FREQUENCY MODULATION

Frequency modulation of the RF output is achieved by modifying the fine tuning of the YIG oscillator. The current supply to the YIG's fine tuning coil is controlled by the FM driver (A103), which in turn is controlled by the output phase lock loop circuit (A6). Normally, the PLL's driver output is derived from the outputs of the phase comparator, suitably filtered and amplified. During operation in the FM mode, however, this phase comparator signal is summed with a modulation signal, providing a modulated drive and resulting in a frequency modulated output from the YIG oscillator.

The FM signal furnished to the output PLL originates on the modulation control board (A118), and is derived from the internal or external modulation signal. This board also houses the logic circuits by which the modulation

mode is selected under local or remote control, as well as the function generator used to produce internal modulation signals.

FREQUENCY SYNTHESIS

The output frequency of the Model 610 is produced by a YIG oscillator. Coarse tuning of the YIG is performed by the YIG driver circuit (A13), a programmable current source which the system computer controls by means of a digital to analog converter and amplifier. This current source (connected to the YIG's "tuning" coil) can bring the YIG frequency within 50 MHz of the desired value. Fine tuning of the YIG is accomplished by the output phase lock loop, which supplies a controlled tuning current to the YIG's "FM" coil. The synthesis process used by the Model 610 involves up to six phase lock loops, depending on output frequency resolution. The following is an introduction to phase lock loop circuits.

PHASE LOCK LOOPS

The purpose of a phase lock loop (PLL) is to control a variable frequency oscillator so that its output frequency has the same accuracy and stability as that of a fixed reference oscillator. It works by comparing two frequency inputs, one fixed and one variable, and supplying a correction signal to the variable oscillator in order to achieve and maintain a constant phase relationship between the two inputs. The following discussion refers specifically to the phase lock loop circuits used in Giga-tronics signal generators, and is not meant to encompass all types of phase lock loops.

The stability and accuracy of a reference frequency (for example, the signal produced by a 10 MHz crystal oscillator) can be transferred to a voltage controlled oscillator (VCO) by means of a phase lock loop. The 10 MHz signal is applied to the reference input of the PLL, and the VCO output frequency is fed back to the variable input of the PLL. A phase detector in the PLL circuit compares the two inputs and determines whether the variable input is leading or lagging the reference. The phase detector has two outputs; pulses

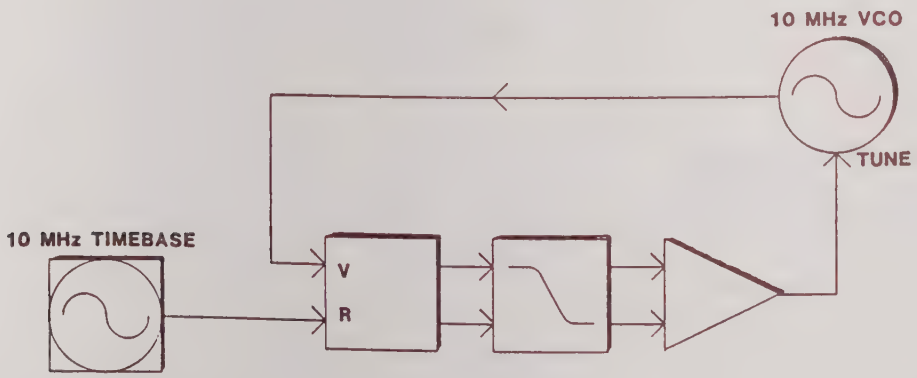


Figure 3.3: Elementary phase lock loop

appear at one of them (which one depends on whether the variable input is leading or lagging), and the width of the pulses is proportional to the degree of phase difference. The pulses are averaged by a low pass filter and DC amplifier into a correction signal, which causes the VCO frequency to increase or decrease in order to reduce the phase difference between the two input frequencies. When the phase error is eliminated, the frequencies are equal, the loop is said to be "locked", and the VCO frequency acquires the accuracy and stability of the reference input.

Although the variable input to the phase detector should equal the frequency of the reference input, it need not equal the frequency of the the VCO. If a frequency divider is introduced between the VCO and the variable input, the VCO can be run at a frequency that is a multiple of the reference frequency. For example, if the VCO output is divided by ten before being applied to the phase detector input, the VCO can run at 100 MHz and still be phase locked to a 10 MHz reference. A frequency divider which intervenes between the VCO and the phase detector's variable input is called a prescaler. If the prescaler is programmable (that is, if it can be set to a given divisor), a variety of frequencies can be phase locked to a single reference frequency.

Since the output frequency must be some multiple of the reference frequency input to the phase detector, the reference frequency limits the resolution of the system: with a 10 MHz timebase, frequencies of 70 MHz or 80 MHz could be generated, but not 73 MHz. This is because digital frequency dividers can perform integer divisions only; the prescaler cannot be programmed to "divide by 7.3". However, if the reference frequency applied to the phase detector is itself programmable, this difficulty can be overcome, either by using a 1 MHz reference frequency and dividing the output by 73, or by using a 7.3 MHz reference and dividing the output by 10.

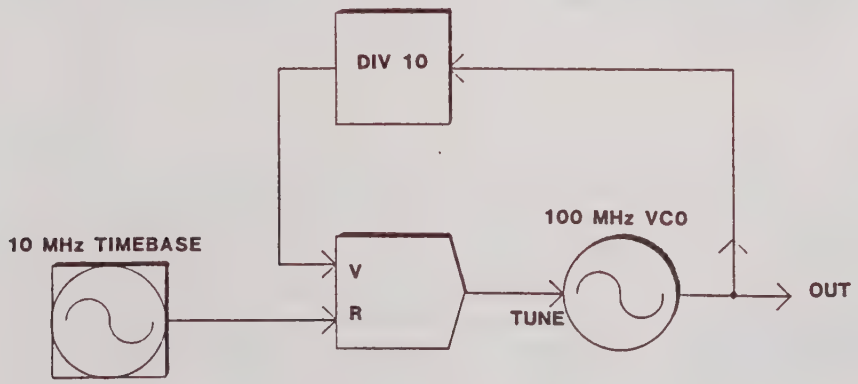


Figure 3.4: 100 MHz phase lock loop.

MICROWAVE FREQUENCY SYNTHESIS

Digital synthesis of microwave frequencies is impeded by two inherent difficulties. First, these frequencies are well above the operating range of digital logic circuits. Second, the bandwidths required tend to be large; even a single-band unit such as the Model 610 must cover an output range of several thousand MegaHertz. A requirement for fine frequency resolution over so wide a range complicates the synthesis process.

In the Model 610, RF mixers are used to downconvert microwave signals to more workable frequencies. Generally, a mixer provides an intermediate frequency equal to the difference between two high-frequency inputs. For example, a step-recovery diode multiplier and an RF mixer (used in a combination known as a sampling mixer) are used to derive a low frequency I.F. equal to the difference between the output microwave signal and some harmonic of a stable 100 MHz input. The various reference signals used to synthesize the output are generated at, or mixed down to, frequencies low enough to drive digital circuits (usually below 200 MHz).

The problem of bandwidth, insofar as it limits frequency resolution, is overcome through the use of compounded PLL circuits to produce reference frequencies programmable in 1 MHz increments over a wide range. For an instrument with Option 03, six different phase detectors are employed in the loops within loops which synthesize the output signal; the benefit purchased by this seemingly high degree of complexity is an output resolution of 1 kHz (one part in 8 million for a Model 610 having an 8 GHz output bandwidth).

THE SYNTHESIS NETWORK

All output frequencies are synthesized by the output PLL, and are ultimately phase locked to the 10 MHz master reference. The synthesizer can be analyzed as two parallel branches connecting the master reference to the output PLL's reference and variable inputs. The variable branch includes feedback from the output YIG oscillator.

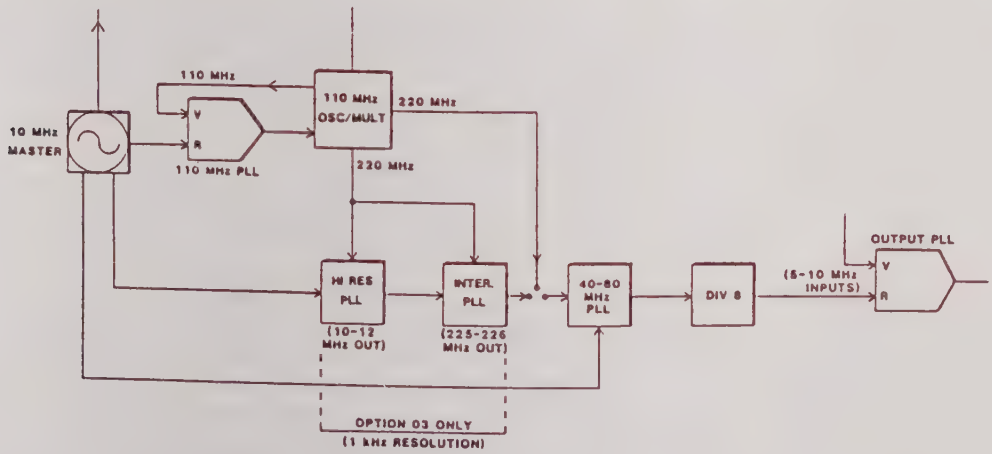


Figure 3.5: The reference branch

THE REFERENCE BRANCH

1 -- 10 MHz master reference (see A12)
2 -- 110 MHz PLL (A12)
3 -- 110 MHz oscillator/multiplier (A113)
3 -- high resolution PLL (A10, Option 03 only)
4 -- intermediate PLL (A9, Option 03 only)
5 -- 40-80 MHz PLL (A8)
6 -- divide-by-8 (A7)
7 -- output PLL, reference input (A6)

The master reference is the instrument's 10 MHz timebase (either the built-in oscillator or an externally applied reference signal -- see the 10 MHz input/output circuit located on the A12 PC board).

The 110 MHz PLL is used to phase lock the 110 MHz voltage controlled oscillator (on the A113 board) to the 10 MHz timebase. A sample of the VCO frequency is divided by 11 and applied to the variable input of a phase comparator; the timebase is the reference input. The phase comparator output is used to generate a tuning voltage for the VCO. The PLL increases or decreases the oscillator frequency until the phase detector inputs match. The 110 MHz oscillator/multiplier generates the 220 MHz and 330 MHz reference signals that are required by other circuits (including the High Resolution PLL and the intermediate PLL in instruments with Option 03). It contains a 110 MHz VCO (tuned by the PLL circuit described above), a frequency doubler (for the 220 MHz reference), and a frequency tripler (for the 330 MHz reference).

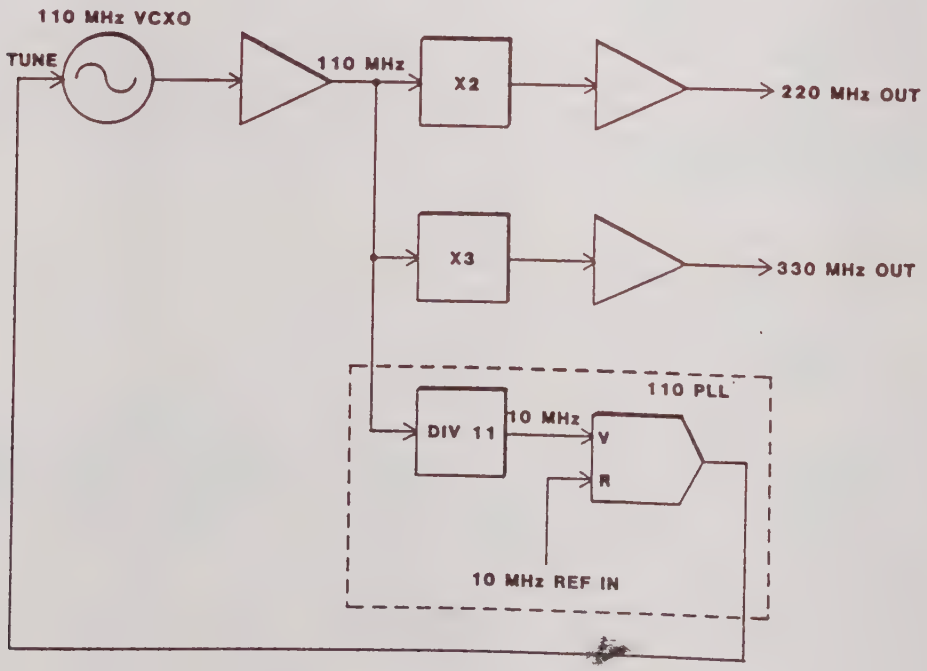


Figure 3.6: 110 MHz Oscillator/Multiplier and Phase Lock Loop

The High Resolution PLL is a programmable source, generating frequencies in 2 kHz increments between 10 and 12 MHz. It is used in instruments with option 03 (1 kHz Resolution). A 250-300 MHz VCO, with a divide-by-25 circuit on its output, is the source of the 10-12 MHz signal. The VCO is tuned by a phase lock loop circuit, but its output is not fed back directly to the phase comparator because the 250-300 MHz frequency range is too high. Instead, the VCO frequency is applied to a mixer. The other mixer input is the 220 MHz reference signal from A113. The 30-80 MHz IF from the mixer is applied to a programmable divider; the divider output (50 kHz when the loop is locked) is applied to the phase comparator's variable input. The reference input is the 10 MHz timebase, divided by 200 for a fixed 50 kHz reference. The PLL tunes the VCO until the two comparator inputs match. The 10-12 MHz output is used by the intermediate PLL as a reference.

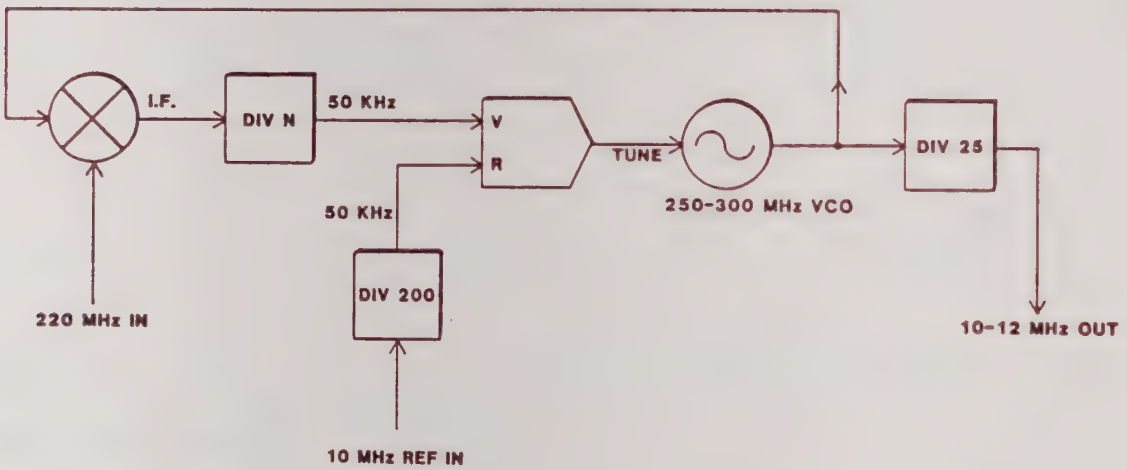


Figure 3.7: High Resolution Phase Lock Loop

The intermediate PLL is a programmable source, generating frequencies in 1 kHz increments between 225 and 226 MHz. It is used in instruments with Option 03 (1 kHz Resolution). A VCO is the source of the 225-226 MHz output. The VCO frequency is fed back to a mixer, where it is combined with the 220 MHz reference input from A113. The resulting 5-6 MHz IF is applied to the variable input of the phase comparator. The 10-12 MHz reference signal from A10 is divided by two and applied to the reference input of the phase detector. The PLL circuit tunes the VCO so as to equalize these two inputs. The 225-226 MHz output is used by the 40-80 MHz PLL as a reference.

The 40-80 MHz PLL is a programmable source, generating frequencies between 40 and 80 MHz. The output frequency is an IF generated by mixing the output of a 266-305 MHz VCO with the 225-226 MHz reference input from the intermediate PLL (A9). In instruments without Option 03, this 225-226 input is replaced by the 220 MHz reference from A113. The VCO is tuned by a PLL circuit; its output is fed back through a frequency divider having a fixed divisor of four, followed by a programmable divider which reduces the feedback signal to 250 kHz and applies it to the variable input of the phase detector. The reference input to the phase detector (also 250 kHz) is obtained by dividing

the 10 MHz reference input by 40. The phase lock loop circuit tunes the VCO until these two inputs match.

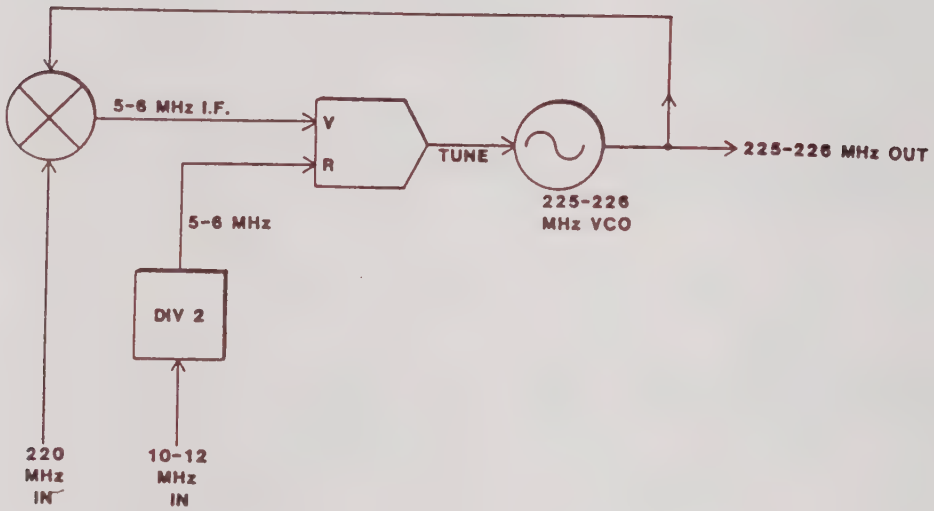


Figure 3.8: Intermediate Phase Lock Loop

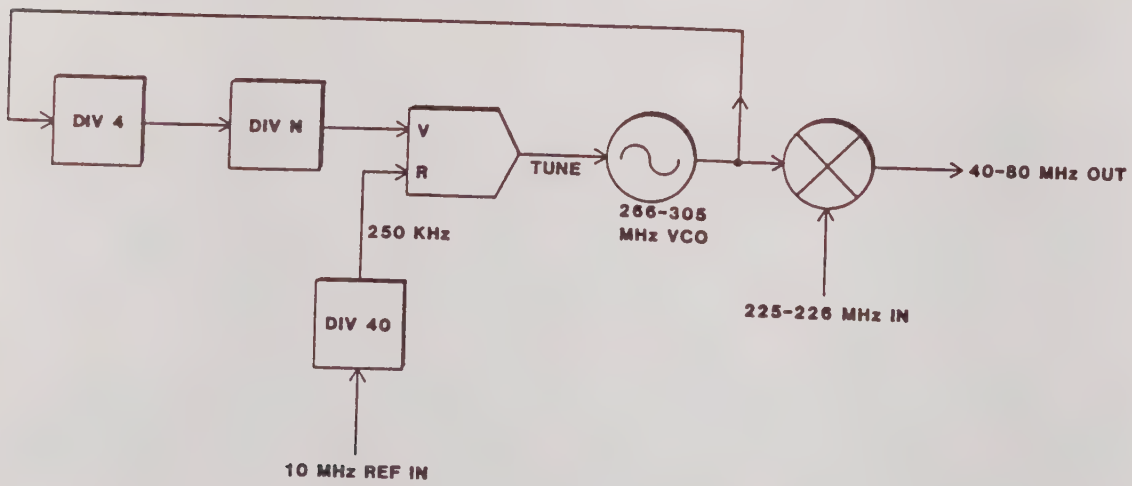


Figure 3.9: 40-80 MHz Phase Lock Loop

The divide-by-8 circuit is a binary frequency divider which accepts the 40-80 MHz reference and divides it by 8; the output signal (a 5-10 MHz reference programmable in 0.125 kHz increments) is the reference input to the output PLL circuit.

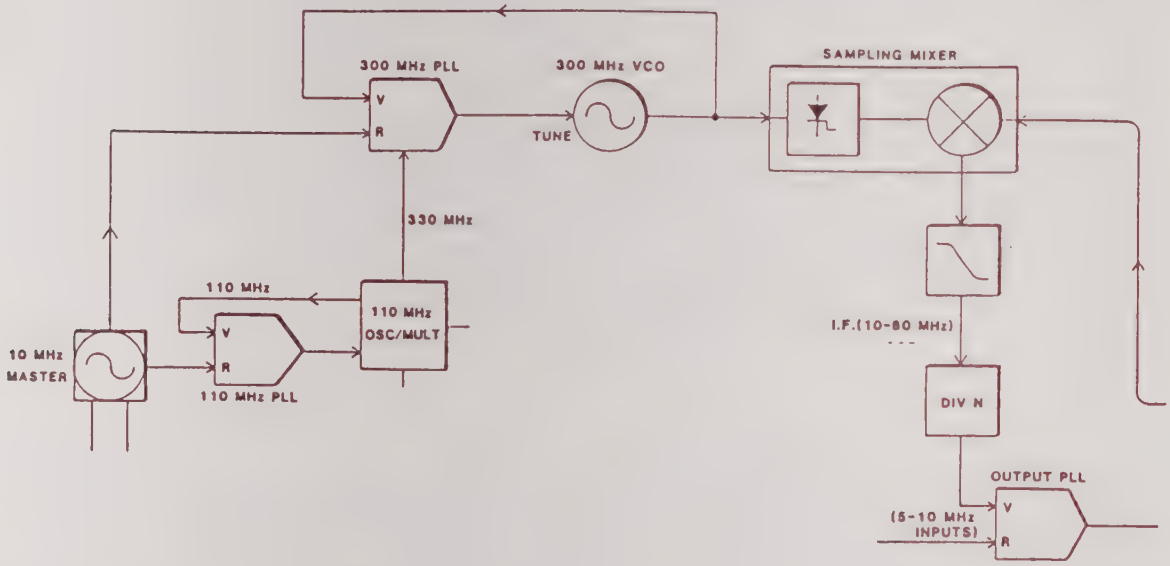


Figure 3.10: The Variable Branch

THE VARIABLE BRANCH

This branch consists of circuits in the following sequence:

1 -- 10 MHz master reference (see A103)
2 -- 110 MHz PLL (A12)
3 -- 110 MHz oscillator/multiplier (A113)
4 -- 300 MHz PLL (A11)
5 -- 300 MHz VCO/driver (A104)
6 -- sampling mixer/IF amplifier (A104)
7 -- divide-by-N (A7)
8 -- output PLL, variable input (A6)

The 10 MHz master reference and the 110 MHz PLL are the same circuits used in the reference branch.

The 110 MHz oscillator/multiplier also supplies a 330 MHz reference input to the 300 MHz PLL.

The 300 MHz PLL is a programmable source, generating frequencies in 1 MHz steps between 284 and 319 MHz. A VCO, tuned by a phase lock loop circuit, generates the output frequency. The VCO frequency is mixed with the 330 MHz input (from circuit board A113) to produce an IF which is then applied to a

programmable divider; the IF is reduced to 1 MHz and applied to the variable input of the phase detector. The reference input, also 1 MHz, is obtained by dividing the 10 MHz reference input by 10. The PLL tunes the VCO until these two phase detector inputs match.

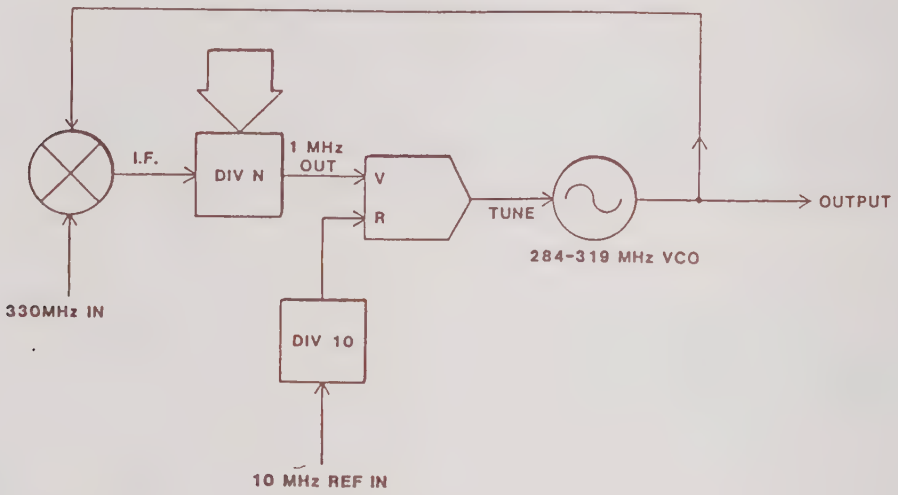


Figure 3.11: 300 MHz PLL/VCO

The 300 MHz VCO/driver is controlled by the 300 MHz PLL. Its output is amplified and used to drive the multiplier input of the sampling mixer.

The sampling mixer has a step recovery diode multiplier on one of its inputs (the input driven by the 300 MHz VCO). The multiplier produces a series of frequency components that are harmonics of the input. The other input to the mixer is a signal coupled from the output of the YIG oscillator. The mixer combines the YIG frequency with the harmonics of the VCO frequency, yielding a great variety of intermediate frequency (IF) components. The IF output is amplified and filtered in order to pass only IFs within a 10-80 MHz range. In this way the output is limited to a single IF component, derived from the difference between the YIG frequency and one of the VCO's harmonics. The IF (a signal programmable over a range of 10 to 80 MHz) is applied to the divide-by-N circuit.

The divide-by-N circuit is a programmable frequency divider; the computer programs it to divide the IF by 2, 4, or 8 in order to produce an output frequency in the range of 5 to 10 MHz. The output is applied to the variable input of the output phase lock loop. The amplified and filtered phase detector output of the PLL is further amplified by the FM driver circuit (see A103) before being applied to the YIG's FM coil. The YIG is tuned in order to adjust the sampling mixer IF and thus equalize the reference and variable inputs to the PLL.

The various programmable frequencies are set by the computer, in accordance with a complex algorithm, to produce the requested output frequency.

DIGITAL FREQUENCY SWEEPING

The Model 610 can be swept through a given frequency range in either of two ways; it is convenient to discuss these modes separately, as digital sweep and analog sweep.

In 'digital' sweep (this mode is designated 'STEP' on the 610's front panel) the instrument generates a rising series of fixed frequencies. The step size and step rate are adjustable. The instrument acquires phase lock at each frequency before proceeding to the next. The sweep direction is always from lower frequency to upper frequency, resetting to the lower. A voltage proportional to progress through the sweep is available, with 0 volts at the start frequency and +10 volts at the stop frequency. A pen lift output signal is provided for controlling a recorder pen: the signal is low (a transistor to ground) during sweep reset or when the sweep is in hold. A single sweep or single step can be initiated by means of a trigger input as well as by pushbutton. The digital sweep mode is not fundamentally different from fixed-frequency signal generation; it simply takes advantage of the computer's ability to issue a sequence of commands automatically.

ANALOG FREQUENCY SWEEPING

In this mode, which makes possible a much faster sweep, the operation of the instrument is significantly altered. An analog sweep is too rapid to permit direct control of all functions by the computer. The normal processes by which the computer retrieves data from memory and calculates control settings would introduce unacceptable delays during the sweep. For this reason, the various analog sweep circuits are designed to operate automatically in response to a clock signal. All calculations and data retrieval from PROM chips are performed by the computer before the sweep commences.

During fixed-frequency operation, the output YIG oscillator is furnished with a fixed tuning current from the YIG driver circuit, and a variable tuning current from the output PLL. During operation in the analog sweep mode (designated 'CONT' on the front panel) this situation is reversed. The coarse-tuning control signal from the YIG driver consists of a ramp, and the control signal from the phase lock loop is fixed.

Each YIG driver circuit houses two digital to analog converters, one using a fixed voltage reference and one using a voltage ramp as a reference. Each DAC output is proportional to the product of the reference voltage input and a binary multiplier selected by the computer. The driver output is the sum of the two DAC outputs. In fixed-frequency or digital sweep operation, only the first DAC is active (the second DAC contributes nothing to the driver output signal). When the instrument is operated in the analog sweep mode, the first DAC is tuned to the sweep start frequency and is held at that value.

The second DAC exists in order to add an increasing offset value to the frequency tuned by the first DAC; in order to accomplish this effect, a voltage ramp is applied to the second DAC's reference input. The output of the second DAC is therefore a ramp, starting from zero. The binary multiplier with which the second DAC is programmed remains fixed throughout the sweep;

Fig 3.12: Analog Sweep

the computer sets the range (i.e., the stop frequency) of the sweep through selection of an appropriate multiplier for the second DAC.

The various ramps employed in the analog sweep mode are generated (on analog sweep PC boards A24 and A25) by a technique in which a clock frequency drives a 12-bit up-counter, and the counter's output lines are used to program a 12-bit DAC. The output "ramp" produced by the DAC is really a staircase, having a maximum of 4096 steps. The computer sets the sweep rate by selecting a clock frequency to drive the up-counter.

Ordinarily, the output phase lock loop acts to compensate for any change in the YIG driver tuning current, and this would interfere with the analog sweep process. For this reason, the output PLL must be disabled during the sweep. At the beginning of the sweep, the generator is tuned and locked to the start frequency. A sample-and-hold circuit is used to "save" the output PLL's control signal at this point, and the loop is deactivated; the PLL remains frozen at the start-frequency value, so that frequency error during the sweep will be minimized. This process causes a setup delay of about 35 milliseconds at the beginning of each sweep or sweep band. In instruments which feature the .01-2 GHz "downconverter" range, all frequencies below 2 GHz are considered to be in a separate band for sweep purposes; the instrument must be locked to the start frequency within a particular sweep band before the sweep can proceed.

The sample-and-hold circuit (A27) uses an oscillator-driven counter and DAC to produce an output ramp which is compared to the control signal fed back from the output PLL. When the ramp matches the PLL signal, the counter stops incrementing, the PLL is disabled, and the saved control signal is applied to the YIG's fine tuning coil.

The '.5V/GHz' output on the 610's rear panel furnishes a voltage directly proportional to frequency during the sweep. This output is generated on the A25 board by means of a circuit very similar to the YIG drivers. The outputs of two DACs are summed to produce the output signal. One DAC is set to a fixed "start" value selected by the computer; a second DAC produces a ramp output because its binary multiplier inputs are produced by a clock-driven up-counter. The two outputs are combined and furnished to the output connector.

At the beginning of the sweep, the computer stores a table of data in RAM chips on the A25 board. The data table contains information about the various frequency points in the sweep range, including the presence or absence of a marker at each frequency. During the sweep, the output lines of a binary up-counter strobe the RAM memory locations successively. The output data lines from the RAM chips drive a DAC in order to produce the 10 volt 'SWEEP OUT' ramp, which is proportional to progress through the sweep. In addition, the RAM output data line representing the marker bit is combined with an "unblank" logic line (which is high only during the sweep) to produce the composite 'UNBLANK/MARKER' output signal. The 'UNBLANK/MARKER' output is used to modulate the Z-axis input of an oscilloscope; its levels are +5 volts (dark for retrace), 0 volts (normal level during the sweep), and -5 volts (bright to indicate a frequency marker).

The level correction system used during fixed-frequency operation is not compatible with analog sweep, because of the time required for the computer to read characterization data stored in ROM. At the start of an analog sweep, the computer retrieves characterization data for the frequencies that will be included in the sweep, and stores this data in RAM chips on the A26 board. During the sweep, an oscillator-driven up-counter addresses the RAM memory locations successively and the output data bits from the RAMs are applied to a DAC. The DAC converts the data into a correction signal for the level control circuit (A7).

A separate system of filter path switching is required during analog sweep because the computer is not able to control this function directly. At the start of a sweep, the computer stores data concerning filter ranges in a RAM chip on the A26 board; during the sweep, an oscillator-driven up-counter strobes the memory locations successively, and the RAM output bits are decoded in order to provide drive signals to turn the filters in the RF path on and off.

REMOTE INTERFACE

All functions of the 610 may be controlled by way of the General Purpose Interface Bus, which conforms to the IEEE-488-1978 standard. An integrated circuit GPIB adapter circuit facilitates communication between the 610 and the bus by processing the general "interface" messages, and by transmitting device-dependent messages (such as commands addressed specifically to the 610) to the computer. The computer interprets these messages, using a vocabulary stored in ROM, and resonds appropriately by sending control signals to the various instrument circuits and by returning reply messages (such as status and error messages) to the GPIB adapter for transmission to the bus.

CALIBRATION AND TESTING

4.1 CALIBRATION PROCEDURE

4.1.1 Required Test Equipment

Frequency counter covering output frequency range of Model 610; time base accuracy better than 1 part in 10E9; IEEE-488 interface.

Computer/controller: any unit equipped with IEEE-488 interface, such as HP9825, HP85, PET 2001.

Power meter/sensor (HP436A with 8485A or equivalent).

Spectrum analyzer (HP8566 or equivalent, with external mixers as required).

Oscilloscope (Tektronix 2465 or equivalent).

Detector (Wiltron 70S50B or equivalent).

50 ohm termination (Tektronix 011-0049-01 or equivalent).

Pulse generator (Wavetek 802 or equivalent).

Low distortion sine wave generator (Wavetek 182A or equivalent).

FM test fixture (described in this procedure).

Distortion analyzer (HP 339A or equivalent).

Modulation meter (Wavetek 4101 or equivalent).

Directional detector (Krytar 1821 or 26175 or equivalent).

4.1.2 Master Oscillator Calibration

4.1.2.1 Turn on Unit Under Test and allow a 20 minute warmup, covers on.

4.1.2.2 Connect the 10 MHz output on the rear panel of the UUT to the oscilloscope vertical input. Adjust the oscilloscope for a mid to full scale display; .1 ms/cm timebase setting.

4.1.2.3 Connect the output from the frequency standard (10 MHz) to the oscilloscope external trigger input and adjust the oscilloscope to trigger on this signal.

4.1.2.4 Remove the UUT top cover and turn the master oscillator frequency adjust (located under a screw-in cap; the oscillator is mounted on the A32 PC board) until the scope display stands still. Use the X10 expander for more resolution.

4.1.2.5 Replace the screw-in cap on the oscillator.

4.1.3 Output Oscillator Tracking

4.1.3.1 The frequency range of the output YIG oscillator varies for different models in the 610 series. The MIN and MAX calibration frequencies should be within about 1 GHz of the limits of the instrument's frequency range (for example, an output oscillator having a range of 10-18 GHz should be calibrated at 11 and 17 GHz).

4.1.3.2 Turn on UUT, all modulation off, minimum frequency. Allow a 20 minute warmup, covers off.

4.1.3.3 Set output for 0 dBm and connect the frequency counter to the front panel RF OUT connector.

4.1.3.4 Connect the oscilloscope to the test point on PC board A6 (DC coupled, 1V/cm, GND @ center).

4.1.3.5 Adjust the YIG oscillator driver (A13) so that the test point voltage is 0 + .5V with the counter reading the selected frequency to 1 MHz resolution. Use the following steps:

STEP	FREQUENCY	ADJUSTMENT
1	minimum	'MIN' (R4 on PC board A13)
2	maximum	'MAX' (R9 on PC board A13)
3	(repeat steps 1 & 2 as needed)	

4.1.3.6 Starting at the minimum output frequency, increment the frequency in 100 MHz steps, monitoring the test point on PC board A6. Readjust the appropriate controls, if necessary, to maintain the voltage within 1V of ground across the band.

4.1.4 Modulation Meter

4.1.4.1 Turn on UUT, all modulation off, minimum frequency. Allow a 20 minute warmup, covers on.

4.1.4.2 Adjust 'DISP ZERO' (R82 on PC board A5) for a modulation meter reading of 0.00 (FM MHz).

4.1.4.3 Monitor TP1 on PC board A26 with the oscilloscope. Adjust 'ZERO ADJ' (R1 on PC board A26) for 0 V at the test point.

4.1.5 Downconverter(Units Containing the .01-2 GHz Band Only)

4.1.5.1 Turn on UUT, all modulation off, 1 GHz. Allow a 20 minute warmup, covers on.

4.1.5.2 Monitor TP1 on PC board A119 with the oscilloscope. Adjust 'COARSE TUNE' (R29, PC board A119) for 0V ± 2V at the test point.

4.1.6 RF Output Amplitude Calibration

4.1.6.1 Turn on UUT, all modulation off, minimum frequency, level set to -4 dBm. Allow a 20 minute warmup, covers off.

4.1.6.2 Adjust '-4' (R43 on PC board A5) for a reading of -4 dBm as measured by a power meter.

4.1.6.3 Set the output level to +4 dBm, and adjust '+4' (R52 on PC board A5) for a reading of +4 dBm on the power meter.

4.1.6.4 Repeat 4.1.6.2 and 4.1.6.3 as required.

4.1.7 Amplitude Modulation Functions

4.1.7.1 Set UUT:
Pulse -- Off
FM -- Off
AM -- 1 kHz, Max (vernier CW)

4.1.7.2 Monitor A118 pin 9 with the oscilloscope; adjust 'SINE' (R20 on A118) to read 2 Vpp (sine wave). Adjust 'M CAL' (R23 on PC board A5) for 99.0 on the modulation meter (AM%).

4.1.8 Frequency Modulation Functions

4.1.8.1 Set UUT:
Pulse -- Off
AM -- Off
FM -- 1 kHz, Max (vernier CW)

4.1.8.2 Verify a mod meter reading of >5.0 MHz. Monitor A118 pin 10 with the oscilloscope, and adjust 'TRI' (R21, PC board A118) to read a 2 Vpp triangle wave.

4.1.9 Pulse Modulation

4.1.9.1 Set UUT:
AM -- Off
FM -- Off
Pulse -- 1 kHz
Level -- +5 dBm
Output Frequency -- MIN

4.1.9.2 Place a detector on the RF output of the UUT. Apply the detector's output to the oscilloscope, terminated by a 50 ohm

load. Set the oscilloscope to 5 mV/div.

4.1.9.3 Verify a 1 kHz square wave on the detector output. Adjust 'DUTY' (R19, PC board A118) for a 50% duty cycle.

4.1.9.4 Adjust 'FREQ' (R33, PC board A118) for a frequency of 1.000 kHz, ± 5 Hz.

4.1.10 AM Performance

4.1.10.1 Connect the UUT's RF OUT to the spectrum analyzer. Connect the 10 MHz IF output from the spectrum analyzer to the input of the external modulation meter. Connect the AF output of the external modulation meter to the input of the distortion analyzer.

4.1.10.2 Set the UUT to an output frequency listed in the test data sheet at the end of this section, at +3 dBm, with all modulation off. Center the output signal on the spectrum analyzer, span 500 kHz, top ref level. Using the volt meter, monitor TP2 on PC board A5 and adjust 'ZERO' (R26, PC board A5) for a reading of 0.0V.

4.1.10.3 Select the 1 kHz AM mode.

4.1.10.4 Set the analyzer to "zero span" (time domain), linear vertical display, video trigger mode; increase ref level to get display on screen. Adjust the AM vernier for an internal modulation meter reading of 50%.

4.1.10.5 Adjust 'AM' (R49, PC board A5) for a 50% reading on the external modulation meter.

4.1.11 FM Performance

4.1.11.1 In order to calibrate and test the frequency modulation circuits, a special test fixture must be assembled. The recommended FM test fixture includes an RF splitter, two delay lines of unequal length, and an RF mixer. The RF output of the UUT is divided by the splitter into two signals, unequally delayed. The required differential delay can be obtained by using two coaxial cables of, for example, 5 and 10 inches in length. The outputs of these delay lines are furnished to the two inputs of the RF mixer. For certain frequencies which may be identified by experiment, the mixer will produce a DC voltage near zero. The number of "null" frequencies can be increased by making the delay lines longer in absolute terms or by increasing the ratio between their lengths. If the output becomes frequency modulated, the mixer output voltage will change, and the voltage variation will be proportional to FM deviation. The polarity of the voltage change may be either directly or inversely related to the direction of frequency

deviation. When voltage levels have been established for different frequencies, the mixer output can be monitored on an oscilloscope to provide a continuous display of FM deviation.

4.1.11.2 Connect the FM test fixture to the RF OUT connector of the UUT. Monitor the mixer output with the oscilloscope (5 mV/div). Set the UUT to a null frequency (that is, to a frequency for which the mixer output voltage is zero); +5 dBm out, no modulation.

4.1.11.3 Establish the voltages at 5 MHz above and 5 MHz below the null frequency. Adjust the oscilloscope gain and the UUT output power level (near +5 dBm) in order to place the null point at the center of the screen and the 5 MHz deviation points at 3 divisions above and 3 divisions below the null point.

4.1.11.4 Apply a 1 kHz external sine wave (2 Vpp into 50 ohms) to the FM BNC. Set the UUT to the FM external mode. Adjust the FM vernier for a modulation meter reading of 5 MHz deviation (FM position). Adjust 'CAL' (R42, PC board A6) to read exactly 6 divisions (peak to peak) on the scope.

4.1.12 Sweep Performance

4.1.12.1 Monitor TP1 (PC board A27) with the oscilloscope and counter. Ground TP2 of the same board. Adjust 'CLK' (R3, PC board A27) for a reading of 300 kHz $\pm$ .5 kHz. Remove ground from TP2.

4.1.12.2 Select a frequency in the middle of the UUT's range. Set the RF level to +4 dBm.

4.1.12.3 Connect the detector to the UUT RF output and to the oscilloscope vertical input. Connect the UUT SWEEP OUT to the oscilloscope horizontal input. Adjust the scope for a 1 dB/V vertical display (centered on the UUT's +4 dBm level) and a full horizontal display of the UUT frequency range. The UUT frequency and level settings may be changed temporarily to set up the oscilloscope screen.

4.1.12.4 Select analog sweep ('CONT'), sweep time 200 msec, full frequency range.

4.1.12.5 Adjust 'LVL' (R61, PC board A5) to align the sweep level trace as closely as possible with the CW +4 dBm level.

4.1.12.6 Connect the BLANK/MARKER output BNC to the oscilloscope Z-axis input.

4.1.12.7 (Units Containing the .01-2 Downconverter Band Only) Set Marker #1 to 1.9 GHz. Adjust '<2' (R20, PC board A13) for the best possible level flatness in that part of the sweep which is before the 1.9 GHz marker.

4.1.12.8 Adjust '>2' (R29, PC board A13) for the best possible sweep level flatness above 2 GHz.

4.1.12.9 Set UUT sweep time to 10 msec and adjust 'RT1' (R23, PC board A13) for the best possible level flatness throughout the sweep range.

4.1.12.10 Set UUT sweep time to 20 msec and adjust 'RT2' (R24, PC board A13) for the best possible level flatness throughout the sweep range.

4.2 PERFORMANCE CHECK

4.2.1 Required Test Equipment

See 4.1.1, page 4-1.

4.2.2 Frequency Range

4.2.2.1 Allow UUT to warm up (power on) for at least 20 minutes; 1 hour for units with Option 06 (high stability timebase).

4.2.2.2 Connect the UUT RF output to the frequency counter. Run the UUT self-test routine in 100 MHz steps (set frequency switches to 90100.000) and monitor the counter to verify frequency accuracy.

4.2.3 Maximum Output Amplitude

4.2.3.1 Connect the UUT RF output to the power meter. Run the UUT self-test routine in 50 MHz steps (90050.000) at specified max power, and monitor the power meter to verify that the output power is within specification across the UUT's frequency range.

4.2.4 Output Power Accuracy

4.2.4.1 Perform the UUT self-test as in step 4.2.3.1 above, at 0 dBm and at -4 dBm.

4.2.5 Frequency Accuracy and Resolution

4.2.5.1 Check each frequency setting digit from 0 to 9 (as applicable) for correct UUT display and frequency counter reading.

4.2.6 Spectral Purity/Step Attenuator

4.2.6.1 Perform spectral purity tests as required by Test Data Sheet.

4.2.6.2 Perform On/Off test as follows:

Set HP-8566:
Span = 200 kHz
Center & Top Ref Level
Span = 0 Hz
VBW = 300 Hz
Trigger = Video

Set UUT:
Pulse Rate = 50 Hz Ext

4.2.6.3 Perform 10 dB step attenuator test as follows:

Set HP-8566:	Set UUT:
Span = 50 kHz	RF level = -5 dB
Center & Top Ref Level	Frequency = min +47 MHz
	Modulation = off

Decrement RF level in 10 dB steps, and verify level accuracy ± 2 dBm. At -65 dBm change HP-8566 span to 200 Hz and step the reference level down five times (to about -50 dBm). Continue the test to -105 dBm. If more range is needed, set HP 8566 attenuator to 0 dB.

4.2.7 AM Functions

4.2.7.1 Set controls as follows:

Pulse - off	Frequency - any
FM - off	Level +5
AM - 1 kHz, Max (Vernier CW)	

4.2.7.2 Attach detector to RF output, scope detector's output, 5 mV/Div, 50 ohms. Verify 1 kHz sine wave on scope. Verify a modulation meter reading of >90% (AM%).

4.2.7.3 Set the Front Panel AM switch to the EXT position. Apply a sine wave at 10 kHz 1.5 Vpp to the AM EXT IN BNC. Verify a reading of 70% AM ± 20% on the modulation meter.

4.2.8 FM Functions

4.2.8.1 Set controls as follows:

Pulse - off	Frequency - any
AM - off	Level +5
FM -1 kHz, Max (Vernier CW)	

4.2.8.2 Attach FM fixture (see calibration procedure, 4.1.11) to RF out. Use one of the frequencies listed on the FM test fixture. Scope FM fixture output 5mV/div. A.C. Verify 1 kHz triangle wave and a modulation meter reading of >5.0 MHz (FM MHz).

4.2.8.3 Set the Front Panel FM switch to the EXT position. Apply a sine wave at 10 kHz (2 Vpp into 50 ohms) to the FM EXT IN BNC. Verify a Mod Meter reading of >5 MHz (FM MHz) and a 10 kHz sine wave on fixture's output.

4.2.9 Pulse Modulation Functions

4.2.9.1 Set control as follows:

Set UUT:
AM - Off
FM - Off
Pulse - 1 kHz

Level +5dB
RF Frequency MIN

4.2.9.2 Place a detector on the UUT's RF output. Apply the detector's output to the oscilloscope, terminated by a 50 ohm load. Monitor the detector's output at 5mV/DIV. Verify a 1 kHz square wave, ± 10 Hz, on the detector's output.

4.2.9.3 Set pulse modulation switch to the EXT position. Apply a 10 kHz square wave (TTL Levels) to the pulse EXT IN BNC and verify a 10 kHz modulation waveform is present on the detector's output.

4.2.10 Remote Modulation

4.2.10.1 Attach UUT to instrument controller via the IEEE-488 interface bus. Set UUT Address to 6.

4.2.10.2 Initialize UUT by sending the following command:

Output 706 "FAXXXX, Level 0" (where "XXXX" represents any valid frequency).

4.2.10.3 Send the following commands and verify appropriate AM functions:

OUTPUT 706 "AM INT" (Internal AM 1 kHz sinewave)
OUTPUT 706 "Panel AM" (Front Panel AM depth vernier activated)
OUTPUT 706 "Preset AM" (Preset AM depth pot activated)
OUTPUT 706 "AM EXT" (External AM)
OUTPUT 706 "AM OFF" (AM deactivated)

4.2.10.4 Send the following commands and verify appropriate FM functions:

OUTPUT 706 "FM INT" (Internal FM 1 kHz triangle)
OUTPUT 706 "Panel FM" (Front Panel FM deviation vernier activated)
OUTPUT 706 "Preset FM" (Preset FM deviation pot activated)
OUTPUT 706 "FM EXT" (External FM)
OUTPUT 706 "FM OFF" (FM deactivated)

4.2.10.5 Send the following commands and verify appropriate pulse modulation functions:

OUTPUT 706 "Pulse INT" (Internal pulse modulation 1 kHz)
OUTPUT 706 "Pulse EXT" (External pulse modulation)

OUTPUT 706 "Pulse OFF" (Pulse modulation deactivated)

4.2.11 Pulse Shape

4.2.11.1 Check pulse shape with an external 50 kHz square wave (TTL levels), for each frequency shown on the test data sheet, as follows: (Do not include undershoot of <2 dB in measurement.)

4.2.11.2 Set controls as follows:

RF Out - +5 dBm
Pulse - External

4.2.11.3 Monitor RF output with detector and scope. Adjust scope so that the waveform covers 5 divisions, centered vertically (10% and 90% are at -2 and +2 divisions). Verify overshoot and undershoot are <2 dBc.

4.2.11.4 Set pulse switch to off. Verify CW level equals the pulse level, $\pm$ 1dB.

4.2.11.5 Set pulse switch to EXT. Verify rise time and fall time are within specification and record values. Adjust scope as required.

4.2.11.6 Repeat 4.2.11.2 through 4.2.11.5 for each frequency shown on the test data sheet.

4.2.12 Miscellaneous Functions

4.2.12.1 Check 'INT CLK 10 MHz' with scope (2 Vpp into 50 ohms).

4.2.12.2 Connect 'INT CLK OUT' to 'EXT CLK IN'; verify UUT unlocks.

EXTERNAL ALC

4.2.12.3 Set EXT ALC to enable position. Verify level display shows "-.----", UUT unleveled.

4.2.12.4 Connect 18 GHz 10 dB directional coupler/detector to UUT RF Out. Connect detector output to EXT ALC input. Connect power meter to coupler RF output.

4.2.12.5 Adjust RF level switches to read +4 dBm on display. Adjust EXT ALC GAIN to read +4 dBm on power meter.

4.2.12.6 Set RF level switches to read -4 dBm on display. Adjust EXT ALC OFFSET to read -4 dBm on power meter.

4.2.12.7 Repeat 4.2.12.5 and 4.2.12.6 as required.

4.2.12.8 Connect power meter to UUT RF Out. Set UUT RF Level switches to 0.0 dBm. Increase level setting in .1 dB steps, to +0.9 dBm; verify accuracy on power meter, ± 0.1 dB.

4.2.12.9 Increase level setting in 1 dB steps, to 9 dBm; verify accuracy on power meter, ± .2 dB.

4.2.13 AM Depth and Distortion; FM Deviation

4.2.13.1 Connect the UUT's RF OUT to the spectrum analyzer. Connect the 10 MHz IF output from the spectrum analyzer to the input of the external modulation meter. Connect the AF output of the external modulation meter to the input of the distortion analyzer.

4.2.13.2 Set the UUT to an output frequency listed in the test data sheet, at +3 dBm, with all modulation off. Set center and top ref level on the spectrum analyzer, span 500 kHz, recenter and top ref level.

4.2.13.3 Turn the AM switch to the 1 kHz mode.

4.2.13.4 Set analyzer to "zero span" (time domain), linear vertical display, sweep time 10 ms, video trigger mode, increase ref level to get display on screen. Adjust the AM vernier for an internal modulation meter reading of 80%. Verify an external modulation meter reading of 70-90%.

4.2.13.5 Adjust the AM vernier for an internal modulation meter reading of 20%, and verify an external modulation meter reading of 10-30%.

4.2.13.6 Adjust the AM vernier for an internal modulation meter reading of 50%, and verify an external modulation meter reading within specification.

4.2.13.7 Verify a distortion meter reading within specification. Record in table on data sheet. Repeat 4.2.13.2 - 4.2.13.7 for other frequencies in table.

4.2.13.8 Attach a detector to the UUT's RF OUT connector. Monitor the detector's signal with the oscilloscope (terminate the detector into a 50 ohm load). Set the scope to 5 mV/div.

4.2.13.9 Apply an external sinewave (2 Vpp) to the AM IN BNC, RF output at +5, AM at External. Adjust the function generator vernier to see a waveform 6 divisions high on the scope (for that setting the internal modulation meter reading should be roughly 35%).

4.2.13.10 Check the AM frequency resoponse: vary the AM rate across the 10 Hz - 50 kHz range, and note the amplitude of the detector output waveform throughout this range. Find the max amplitude point. Adjust the AM vernier to get 8 divisions. Verify that the waveform is between 4 and 8 divisions across the 10 Hz - 50 kHz range.

4.2.13.11 (Frequency Modulation Performance) In order to calibrate and test the frequency modulation circuits, a special test fixture must be assembled. The recommended FM test fixture includes an RF splitter, two delay lines of unequal length, and an RF mixer. The RF output of the UUT is divided by the splitter into two signals, unequally delayed. The required differential delay can be obtained by using two coaxial cables of, for example, 5 and 10 inches in length. The outputs of these delay lines are furnished to the two inputs of the RF mixer. For certain frequencies which may be identified by experiment, the mixer will produce a DC voltage near zero. The number of "null" frequencies can be increased by making the delay lines longer in absolute terms or by increasing the ratio between their lengths. If the output becomes frequency modulated, the mixer output voltage will change, and the voltage variation will be proportional to FM deviation. The polarity of the voltage change may be either directly or inversely related to the direction of frequency deviation. When voltage levels have been established for different frequencies, the mixer output can be monitored on an oscilloscope to provide a continuous display of FM deviation.

4.2.13.12 Connect the FM test fixture to the RF OUT connector of the UUT. Monitor the mixer output with the oscilloscope (5 mV/div). Set the UUT to a null frequency (that is, at a frequency for which the mixer output voltage is zero -- see list of frequencies); +5 dBm out, no modulation.

4.2.13.13 Establish the voltages at 5 MHz above and 5 MHz below the null frequency. Adjust the oscilloscope gain and the UUT output power level (near +5 dBm) in order to place the null point at the center of the screen and the 5 MHz deviation points at 3 divisions above and 3 divisions below the null point.

4.2.13.14 Apply an external sinewave (2 Vpp 50 ohms) to the FM BNC. Set the UUT to the FM external mode. Adjust the FM vernier for a modulation meter reading of 5 MHz deviation (FM position).

4.2.13.15 Verify that peak to peak deviation is less than 8 divisions, and greater than 4 divisions, at all FM rates from 10 Hz to 1 MHz (external mode). Check each frequency range.

4.2.13.16 FM Meter Accuracy: Adjust the external sinewave frequency to 123 kHz. Adjust the FM vernier fully CCW. Connect the UUT RF OUT to the spectrum analyzer, center, span 1 MHz.

4.2.13.17 Adjust the FM vernier slowly CW and observe the carrier null 8 times. Adjust for the best 8th null- this will be the Bessel null for 3 MHz peak deviation. Verify that the FM Modulation Meter reads 3.00 MHz +/- 10%. Repeat for 125 KHz rate, first null = .30 MHz deviation, ± 10%.

4.2.14 Step Sweep

4.2.14.1 Set UUT to Start/Stop, one band 1 GHz range (ex 2-3 GHz), Step Sweep, step size 100 MHz.

4.2.14.2 Start/Stop: Connect RF Out to Counter. Verify correct start and stop frequencies.

4.2.14.3 Sweep Time: Connect Sweep Out to Scope vert. Verify correct step time +/-20% for sweep(each step) times of 1S, 100mS, and 30mS.

4.2.14.4 Sweep out Up/Down: Verify 11 steps 0 to 10V UP and 10V to 0V DOWN. Test rear panel BNC if applicable.

4.2.14.5 Pen Lift: Connect Scope to Pen Lift. Verify pulse 5V to 0V during retrace.

4.2.14.6 Marker/Blank: Connect Scope to Marker/Blank. Verify pulse 0 to 5V between steps, approx. 10mS wide.

4.2.14.7 Step Size: Select 1 KHz step size. Verify frequency display changes in 1 KHz increments. Repeat for 10 KHz - 1 GHz step sizes. (1, 10, 100 KHz increments opt. 03 only.)

4.2.14.8 Single Sweep: Select single sweep mode. Verify UUT goes to HOLD after sweep is complete.

4.2.14.9 Stop/Reset: Select auto sweep mode. Select stop/reset UUT stops sweep. Press stop/reset again UUT starts sweep over at Fmin. Stop/Reset light goes out.

4.2.14.10 Ext Trig: Select ext trig. Ground center of sweep sync trig BNC. UUT will sweep once then display HOLD. Test rear panel BNC if applicable.

4.2.14.11 CF: Set sweep time to 200ms. Select CF mode. Set CF to mid band. Set delta to 1.0 GHz. Set step size to 100 MHz. Verify UUT sweeps 500 MHz above and below CF.

4.2.14.12 Delta M: Set M1 to Fmin. Set M3 to Fmin +1 GHz. Verify UUT sweeps from M1 to M3 in 100 MHz steps.

4.2.14.13 Level Flatness: Step sweep full range of UUT, step size 100 MHz. Verify level flatness +/- 1 dB on power meter.

4.2.14.14 Step Frequency Accuracy: Step sweep full range of UUT, step size 100 MHz. Verify frequency accuracy +/- .5 MHz on counter.

4.2.15.1 Continuous Sweep

4.2.15.1 Start/stop: Select CONT. sweep. One band 4 GHz range (ex 4-8 GHz).

4.2.15.2 Sweep Out: Verify 0 to 10 volt ramp, 160 mS +/- 50%. Set stop frequency to Fstart +.5 GHz, sweep time to 10 ms. Verify 10 ms +/- 50% 0 to 10 volt ramp.

4.2.15.3 Sweep time: Set sweep time to 10 ms. Verify 10V ramp = 10 ms +/- 50%. Repeat for 20, 40, 80, 160, ms sweep times.

4.2.15.4 .5 Volt/GHz: Select cont. sweep. Start= Fmin, stop= Fmax. Verify .5 Volt/GHz operation. (ex 2-8 GHz sweep, ramp voltage will be 1 to 4 volts). NOTE: there will be a 50 ms pause at band crossing.

4.2.15.5 Marker/Blanking: Apply sweep out to CH 1 of scope, Blank/Marker to CH 2. Set 5 Markers, spaced 1GHz appart. Verify 5 markers on screen, turn off M1-M5 verify no markers on screen.

4.2.15.6 RF Off: Apply RF out with detector to scope CH2. Verify RF is off during retrace. Verify RF OFF Push Button operation.

4.2.15.7 Single Sweep: Select single sweep mode verify UUT sweeps once then displays HOLD.

4.2.15.8 Stop/Reset: Select auto sweep, sweep time 3 seconds. Press stop/reset verify sweep restarts.

4.2.15.9 EXT Trig.: Select Ext trig. Ground center of sweep sync trig BNC. UUT will sweep once then display HOLD.

4.2.15.10 CF: Select CF mode, set sweep time to 200ms, CF= Mid band, delta 3.0 GHz. Set analyzer center frequency to 1.5 GHz below CF, set analyzer span to 50 MHz , set sweeptime to 10 seconds. Verify UUT start frequency = CF - 1.5 GHz (+/- 15 MHz).

4.2.15.11 Set analyzer center frequency to CF + 1.5 GHz. Verify UUT stop frequency = CF + 1.5 GHz (+/- 15 MHz).

4.2.15.12 Delta M: Set M1 to Fmin and M3 to Fmax of UUT. Select delta M mode. Verify start and stop frequencies on analyzer +/- 15 MHz.

4.2.15.13 Marker Accuracy: Set UUT to full range sweep, sweep time to 200ms and set M1 to marker Fmin + 1GHz.

4.2.15.14 Connect RF out of UUT to analyzer input, level 0dB.

4.2.15.15 Connect marker/blanking of UUT to scope input CH 1, 5V/Div trigger (-) 2V CH 1.

4.2.15.16 Connect 21.4MHz IF output of HP 8566 to scope CH 2, 50 ohms, 10mV/Div.

4.2.15.17 Display CH 1 and 2 on oscilloscope. Channel 1 will be A 50us -5V marker pulse, the scope should be triggered on this pulse.

4.2.15.18 Set HP 8566 to SPAN 100MHz, center frequency = marker test frequency. Then set 8566 SPAN to 0Hz.

4.2.15.19 The IF burst from the analyzer (21.4MHz) should appear on the scope. If it does not, select center frequency on the 8566. Adjust the data knob on 8566 until the IF burst appears on the scope. Continue adjusting center frequency until the IF burst lines up with the marker pulse on scope. Record center frequency reading of analyzer.

4.2.15.20 Marker error = Center frequency reading - Marker frequency Verify Marker accuracy +/- 15 MHz.

4.2.15.21 Level Flatness: Set up scope as in 4.2.15.6; set UUT to cont. sweep full range of UUT. Sweep time= 250 ms. Verify flatness +/- 1 dB.

4.2.15.22 Level Accuracy: Verify sweep level within 2 dB of CW level.

TEST DATA SHEET -- MODEL 610

Quality Assurance _____ Tested By _____

Date _____ S/N _____ Model _____

[X]

4.2.2 Frequency Range

[ ] 4.2.2.2 UUT is locked and leveled throughout its frequency range at +10dBm (or at maximum leveled power in instruments not specified at +10)

4.2.3 Maximum Output Amplitude

[ ] 4.2.3.1 Maximum power exceeds +10dBm (or other max power spec), ± 2 dBm, throughout UUT's frequency range

4.2.4 Output Power Accuracy

[ ] 4.2.4.1 UUT meets the required power accuracy throughout its frequency range, accuracy ± 2 dBm at 0 dBm and 4 dBm

4.2.5 Frequency Accuracy (± 1E10-6) and Resolution

[ ] 4.2.5.1 1 kHz digit function (Option 03)

[ ] 4.2.5.1 10 kHz digit function (Option 03)

[ ] 4.2.5.1 100 kHz digit function (Option 03)

[ ] 4.2.5.1 1 MHz digit function

[ ] 4.2.5.1 10 MHz digit function

[ ] 4.2.5.1 100 MHz digit function

[ ] 4.2.5.1 1 GHz digit function

[ ] 4.2.5.1 10 GHz digit function

4.2.6 Spectral Purity/Step Attenuator

4.2.6.2 & 4.2.6.3 Record readings for all of the following frequencies that are available in the instrument being tested (table on following page). RF level setting is 0 dBm. Frequencies are in MHz. Ignore kHz digits in units without 1 kHz resolution. The second harmonic for each frequency is given in brackets (correct only for units with 1 kHz resolution).

FREQUENCY	SECOND HARMONIC (N/A if out of band)	SPURIOUS (SPAN: 1 GHz TO 50 kHz)	NOISE @10 kHz 1 Hz BW	LINE/FAN SPURS	ON/OFF RATIO
<2 GHz SPEC	<-30 dBc	<-50 dBc	<-75 dBc/Hz	<-45 dBc	>80 dB
>2 GHz SPEC	<-40 dBc	<-55 dBc			
411.226 [822.452]	_____	_____	_____	_____	_____
1333.288 [2666.576]	_____	_____	_____	_____	_____
2409.976 [4819.952]	_____	_____	_____	_____	_____
3536.171 [7072.342]	_____	_____	_____	_____	_____
4988.132 [9976.264]	_____	_____	_____	_____	_____
5447.742 [10895.484]	_____	_____	_____	_____	_____
9182.433 [18364.866]	_____	_____	_____	_____	_____
12317.392	n/a	_____	_____	_____	_____
15421.056	n/a	_____	_____	_____	_____
17361.522	n/a	_____	_____	_____	_____

[ ] 4.2.6.3 10 dB Step Attenuator, accuracy ± 2dBm

4.2.7 AM Functions

[ ] 4.2.7.2 AM Sine wave, 1 kHz fixed

[ ] 4.2.7.3 External AM

4.2.8 FM Functions

[ ] 4.2.7.2 FM triangle wave, 1 kHz fixed

[ ] 4.2.7.3 External FM

4.2.9 Pulse Modulation Functions

[ ] 4.2.9.2 Square wave, 1 kHz fixed

[ ] 4.2.9.3 External Pulse Modulation

4.2.10 Remote Modulation

[ ] 4.2.10.3 Remote AM

[ ] 4.2.10.4 Remote FM

[ ] 4.2.10.5 Remote Pulse Modulation

4.2.11 Pulse Shape

Record readings for all of the following frequencies that are available in the instrument being tested.

FREQUENCY	RISE TIME	FALL TIME
SPEC:	<25 ns	<25 ns
1500		
2500		
4500		
6500		
8500		
11500		
13500		
17500		

4.2.12 Miscellaneous Functions

[ ] 4.2.12.1 10 MHz INT CLK Output, 2 Vpp into 50 ohms

[ ] 4.2.12.2 10 MHz EXT CLK

[ ] 4.2.12.3 External ALC

[ ] 4.2.12.8 Level check (1 dB & .1 dB increments)

4.2.13 AM Depth and Distortion; FM Deviation

Record readings for all of the following frequencies that are available in the instrument being tested.

FREQUENCY	AM DEPTH (%)	AM DISTORTION
SPEC:	50%, ± 10%	<5% at 1 kHz
1500	_____	_____
2500	_____	_____
4500	_____	_____
6500	_____	_____
8500	_____	_____
11500	_____	_____
13500	_____	_____
17500	_____	_____

[ ] FM DEVIATION 5 MHz, 1 MHz BW, ± 3 dB, Meter ± 10%

4.2.14 Step Sweep

[ ] Start/Stop

[ ] Sweep Time

[ ] Sweep Out Up/Down

[ ] Pen Lift

[ ] Marker/Blank

[ ] Step Size

[ ] Single Sweep

[ ] Stop/Reset

[ ] Ext Trig

[ ] CF

[ ] Delta M

[ ] Level Flatness

[ ] Step Frequency Accuracy

4.2.15 Continuous Sweep

[ ] Start/Stop

[ ] Sweep Time

[ ] Sweep Out

[ ] .5V/GHz

[ ] Marker/Blank

[ ] RF Off

[ ] Single Sweep

[ ] Stop/Reset

[ ] Ext Trig

[ ] CF

[ ] Delta M

[ ] Marker Accuracy

[ ] Level Flatness

[ ] Level Accuracy

MAINTENANCE

5.1 GENERAL MAINTENANCE

Under normal operation, this instrument requires little regular maintenance. It is recommended that the calibration procedure (as described in Section 4 of this manual) be performed at nine-month intervals to insure operational accuracy. The air inlet screen should be cleaned whenever a significant amount of dirt has accumulated.

During the warranty period of the instrument, it is recommended that no user initiated service work be performed without first communicating with the factory (or our authorized representative). Often the problem can be readily isolated to a particular plug-in module, for which a replacement can be sent.

C A U T I O N

This instrument contains many MOS and CMOS devices; be sure to use appropriate anti-static procedures whenever it is necessary to handle them.

The larger integrated circuits are plugged into locking sockets. To release the locking mechanism, insert a small screwdriver in the slot at the "pin 1" end of the socket. Press down gently and tilt the screwdriver toward the socket. The IC may now be removed easily. To insert, just press the IC firmly into place, making certain all pins are straight and centered in their guides.

Never remove an IC from its socket unnecessarily.

W A R N I N G

UNPLUG THE INSTRUMENT BEFORE SERVICING! There is no switch in the power line of this instrument. Whenever it is plugged in, all primary and secondary voltages, and some rectified voltages, are present.

It may become necessary to work on the interior of the instrument while it is plugged in and power is on; circuit boards may be placed on extender cards for the purpose of observing their operation within the system. However, circuit boards and other electronic devices must not be inserted into or removed from the instrument while power is being applied to it! Always unplug the instrument before making such changes.

If the instrument appears to be operating abnormally, the procedure in section 5.2 below may be used to isolate the problem and identify the probable cause.

5.2 TROUBLESHOOTING PROCEDURE

5.2.1 Introduction

Before any other analysis is attempted, three potential problem areas must be eliminated. First, be sure that all front AND rear panel controls are properly set. An apparent malfunction may be the result of an operator error,

such as leaving the External ALC switch in the wrong position, or selecting external modulation without furnishing the needed modulation input. Second, establish whether the problem exists only under remote control; if so, the cause could be a malfunctioning controller, an improper bus address, or an erroneous remote control command. Third, clean the plated edges of the plug-in circuit boards with a rubber eraser and alcohol (malfunctions are often caused by an accumulation of dirt on these edges).

5.2.2 Defining the Area of Malfunction

It is important to establish under what circumstances a malfunction does (and does not) occur. Failure may occur in only a portion of the instrument's frequency range or level range, or only in a particular operating mode. Explore different settings and modes in order to find the limits of the malfunction. It may be found that a malfunction occurs only during remote control operation (see 5.2.3.10 below).

Some improper control settings will cause an error message to be displayed; see the list of error messages on page 1-7 of this manual.

5.2.3 Malfunctions

Ten major areas of potential failure are addressed in this procedure. Each problem area is analyzed with a reference to the troubleshooting notes included in section 5.3 (e.g., "see 5.3.1").

5.2.3.1 General Failure

Symptoms: The instrument does not respond appropriately to commands given via the front panel controls or IEEE-488 interface; the readouts are blank, erratic, or fixed in one state.

RECOMMENDATIONS:

Check power supplies (see 5.3.1).

Check computer (see 5.3.2).

5.2.3.2 Loss of RF Output

Symptoms: No measurable power is present at the output connector, regardless of the RF level setting. The front panel 'LEVEL' indicator may or may not be lit.

RECOMMENDATIONS:

Check power supplies (see 5.3.1).

Check 10 dB step attenuator (see 5.3.3).

Check modulator (see 5.3.4).

Check YIG oscillator (see 5.3.5).

5.2.3.3 Incorrect Output Level

Symptoms: Output power is at a level other than that selected by the RF level setting. The front panel 'LEVEL' indicator may or may not be lit.

RECOMMENDATIONS:

Before proceeding, be sure that the selected RF level is within the capability of the instrument. Although the instrument must meet a maximum power specification, the actual maximum will be somewhat in excess of this, and will vary for different frequencies. When exceeding the normal power range, the 'LEVEL' indicator may go out and the instrument's RF output may fall below the level requested.

Check power supplies (see 5.3.1).

If level error is a 10 dB multiple (e.g., -20 dBm instead of +10 dBm), check 10 dB step attenuator (see 5.3.3).

Check leveler (see 5.3.6).

Check detector (see 5.3.7).

Check level control circuit (see 5.3.8).

5.2.3.4 Output Frequency Unlocked

Symptoms: The 'LOCK' indicator on the front panel is dark whenever any phase lock loop circuit in the instrument is unlocked. The output frequency will drift; the degree of frequency error depends on where the fault is.

RECOMMENDATIONS:

Check power supplies (see 5.3.1).

Determine which loop is unlocked (see 5.3.9). If more than one is unlocked, work backwards from the output PLL as described below.

Check output PLL (see 5.3.10).

Where fault is isolated to the output PLL's variable input, check the 'divide-by-N' circuit on the frequency divider board (see 5.3.11).

Check 300 MHz oscillator (see 5.3.12).

Check 300 MHz PLL (see 5.3.13).

Check YIG driver (see 5.3.14).

Check 110 MHz oscillator/multiplier (see 5.3.15).

Check 110 MHz PLL (see 5.3.16).

Check 10 MHz master reference (see 5.3.17).

Where fault is isolated to the output PLL's reference input, check the 'divide-by-8' circuit on the frequency divider board (see 5.3.18).

Check 40-80 MHz PLL (see 5.3.19).

Check intermediate PLL (see 5.3.20).

Check 10-12 MHz PLL (see 5.3.21).

Check 110 MHz oscillator/multiplier (see 5.3.15).

Check 110 MHz PLL (see 5.3.16).

Check 10 MHz master reference (see 5.3.17).

5.2.3.5 Output Locked, but Frequency Incorrect

Symptoms: The 'LOCK' indicator is illuminated; the output frequency is stable, but incorrect.

RECOMMENDATIONS:

The troubleshooting procedure is the same as for the unlocked condition described in section 5.2.3.4 above. The same circuits are likely to be at fault, even if there is no indication of unlock; the problem may be caused by improper control or reference inputs rather than by complete circuit failure.

5.2.3.6 FM Malfunction

Symptoms: The instrument does not frequency modulate its RF output in accordance with the operator's commands.

RECOMMENDATIONS:

Check power supplies (see 5.3.1).

Check FM driver (see 5.3.22).

Check output PLL (see 5.3.23).

Check modulation control circuit (see 5.3.24).

5.2.3.7 AM Malfunction

Symptoms: The instrument does not amplitude modulate its RF output in accordance with the operator's commands.

RECOMMENDATIONS:

Check power supplies (see 5.3.1).

Check leveler (see 5.3.25).

Check level control (see 5.3.26).

Check modulation control circuit (see 5.3.27).

5.2.3.8 Pulse Modulation Malfunction

Symptoms: Instrument does not pulse modulate its RF output in accordance with the operator's commands.

RECOMMENDATIONS:

Check power supplies (see 5.3.1).

Check pulse modulator (see 5.3.28).

Check modulation control circuit (see 5.3.29).

5.2.3.9 Sweep Malfunction

Symptoms: The instrument does not sweep through the selected frequency range in accordance with the operator's commands, or does not generate the auxiliary sweep output signals.

RECOMMENDATIONS:

Check power supplies (see 5.3.1).

Check the YIG driver board (5.3.30).

Check the analog sweep boards (see 5.3.31).

Check the sweep clock/frequency hold board (see 5.3.32).

Check the downconverter/level correction board (see 5.3.33).

5.2.3.10 IEEE-488 Interface Malfunction

Symptoms: Instrument does not respond appropriately to commands sent via the interface, or exhibits a particular malfunction (see 5.2.3.1 through 5.2.3.9 above) only while under remote control.

RECOMMENDATIONS:

Check power supplies (see 5.3.1).

Check GPIB address (see 5.3.34).

Verify that commands used are appropriate to this instrument (see 5.3.35).

Check IEEE-488 circuit (see 5.3.36).

5.3 TROUBLESHOOTING NOTES

5.3.1 Power Supply

This is the common denominator among malfunctions of all types. Because the instrument has many regulated supplies, and they are not all used by all circuits, it is possible for the failure of a single supply to disable only a part of the system. For this reason power supply voltages should be checked whenever there is an instrument malfunction, even though the malfunction may seem too limited or specialized to have such a cause.

The power supply circuit board (A101) is located at the rear of the instrument; filter capacitors C1 through C4 are located along the left side of the instrument beside the computer boards. The individual supplies are:

Computer +5 volts. Used by the computer, TTL circuits, etc. Test point: CPU Bus (A102), J2, pins 57-60 (any card slot). Wire color: red.

RF +5 volts. Used by PLL circuits and other RF circuits. Test point: RF Bus (A103) pins 2/B (any card slot). Wire color: red.

-5.2 volts. Used by ECL-type high speed logic circuits, frequency dividers, etc. Test point: RF Bus, pins 4/D. Wire color: green.

+15 volts. Used by YIG oscillator. Test point: YIG. Wire color: blue.

+24 volts. Used to drive the cooling fan, and also the relays in the 10 dB step attenuator. Test point: PS Capacitor C3, plus terminal. Wire color: blue/orange/white.

+18 volts #1. Used by amplifiers, drivers, etc. Secondary regulators on circuit boards convert the supply to a lower voltage where necessary. Test point: RF Bus, pins 5/E. Wire color: blue/orange.

+18 volts #2. Used as heater voltage and tuning coil current source for YIG oscillator. Test point: YIG. Wire color: blue/orange.

-18 volts. Used by amplifiers, drivers, etc. Secondary regulators on circuit boards convert the supply to a lower voltage where necessary. Test point: RF Bus, pins 3/C. Wire color: violet/orange.

+35 volts. Used by the fluorescent display drivers. Test point: terminal 'C' on CPU bus. Wire color: grey.

8 VAC. Used by the fluorescent display heaters. Also tied to computer +5 volt DC supply. Test point: terminals 'A' and 'B' on CPU bus (two violet wires). AC must be measured across the terminals, not to ground.

Instruments in which option 06 (the high stability timebase) is installed have an additional voltage output, the +15 volt supply. This supply is independent of the power switch, and should be "on" whenever AC power is applied to the instrument. Test point: high stability oscillator. Wire color: blue/black.

CORRECTIVE ACTION

Check the line fuse; replace it if it is open. If the new fuse opens, check the power supply primary and secondary circuits.

If any supply output is at an incorrect voltage, remove all plug-in circuit boards. If the overload ceases, replace the boards one at a time to isolate the fault. If the overload persists, open the supply regulator output and verify regulator input and output voltages.

5.3.2 The Computer

All instrument functions are controlled by the computer, and a general computer failure will lead to a general system failure. The computer is based on the Motorola 6809 microprocessor. It uses a bus architecture which corresponds on a one-to-one basis with the signals from and to the 6809 chip itself, with two exceptions: the DMA/BREQ signal into the 6809 is not used, and the three high order address lines from the 6809 are decoded (on the CPU board) into eight page-lines for the bus.

CORRECTIVE ACTION

Five circuit boards house the computer:

A0 -- This is the Keyboard/LED VIA board, which acts as an interface between the microprocessor and the front panel switches. The board is also used, together with the A1 board, to produce control signals for sweep operation.

A1 -- This is the Display PIA board, which acts as an interface between the microprocessor and other devices, including the front panel readouts. The board also shares sweep control functions with the A0 board.

A2 -- This is the Memory board, which holds the ROM devices in which the instrument's operating software is stored, as well as the RAM chips used by the computer for temporary data storage.

A3 -- This is the IEEE-488 board; it includes the circuits which act as an interface between the computer and the remote control bus. The board also houses circuits through which the computer controls the instrument's digital to analog converters.

A4 -- This is the CPU board, which houses the microprocessor and some of the control logic through which it runs the instrument.

When a computer failure is suspected, the best way to troubleshoot the system is to isolate the problem to board level by substituting known good PC boards. If the problem persists with four known good boards, the problem is most likely on the computer bus board (the motherboard) into which the computer boards are plugged. Many computer problems are caused by dirt on the connections between these boards.

If the computer seems to have become "lost", it can be reset either by pressing the reset button on the CPU board (A4) or by turning the power switch off and on.

5.3.3 10 dB Step Attenuator

The programmable attenuator is capable of attenuating the RF output by as much as 110 dB; if the output is not at the desired power level, the cause may be that the attenuator is improperly set. Note that the attenuator is outside of the leveling loop, and therefore the leveling system cannot detect, or compensate for, attenuator errors.

CORRECTIVE ACTION

The programmable attenuator's internal structure includes a series of relays which add or remove lossy elements in combination (10 dB, 20 dB, 40 dB, etc.) to achieve the desired total attenuation. The relay drivers which select these increments are located on the leveling circuit board (A5). Verify that the attenuator is receiving the appropriate drive signals; if not, investigate the drivers on the leveling board and the computer logic lines which control them.

5.3.4 Modulator

The RF path through the microwave module is divided into two or more (depending on output bandwidth) filter lines; pulse modulation is normally accomplished by turning the active path "off" at intervals. If the filter select/modulator control line for the active path is held at the "off" logic level, the RF signal will be shut down.

CORRECTIVE ACTION

The filter select/modulator control lines applied to the RF module have positive voltages for "off" and negative voltages for "on" (levels are on the order of one volt). The signals originate on the modulation control board (A118). If inappropriate signals are received, investigate

the driver circuits on that board and the computer logic lines which control them.

5.3.5 YIG Oscillator

All YIG oscillators require +15V and +18V supplies; the 2-8 and 6-12 GHz YIGs also require a -5V supply. In addition to the power supply requirements, the YIG oscillator must have current supplied to its tuning coil within an appropriate range in order to generate an RF output of any kind. If tuning coil current is excessive or insufficient, there will be no signal.

CORRECTIVE ACTION

The easiest way to measure coil current is to read the voltage drop across the sense resistor. This is a large, high-wattage, metal-encased resistor (usually 5 or 7 ohms, depending on the oscillator used) mounted near the YIG. One end is grounded, and the other is connected (through an NPN transistor controlled by the YIG driver board, A13) to the negative end of the YIG oscillator tuning coil. The voltage across the sense resistor, divided by its resistance, equals the coil current. Since the tuning sensitivity of the YIG oscillator is 20 MHz/mA, the current (in Amps) for a given frequency may be found by dividing the frequency (in GHz) by 20. Current values corresponding to frequencies outside the range of the oscillator will shut the oscillator down.

If the coil current is out of range, investigate the NPN transistor and the YIG oscillator circuit (A13) which drives its base.

5.3.6 Leveler

The signal path through the RF module includes a voltage controlled attenuator circuit, or "leveler". The level control circuit board (A5) has an output which uses complementary transistors to drive the leveler pin on the outside of the module. The leveler increases attenuation as the input becomes more positive, and reduces attenuation as the input becomes more negative; sensitivity to the control voltage varies for individual instruments. The voltage swing as measured at the module's leveler pin, is (very roughly) from -14 volts to +2 volts.

CORRECTIVE ACTION

When the output level is incorrect, the leveler input voltage may be clearly inappropriate in a way which indicates the cause of the problem. If output power is too low, and the leveler at the positive rail (maximum attenuation), the level control circuit is reducing the output power by sending a bad control signal; if output power is too low and the leveler at the negative rail (minimum attenuation), the level control circuit is trying unsuccessfully to compensate for power loss occurring somewhere in the RF path (the loss could be in the RF module itself). If power is too high, and the leveler at the positive rail (maximum attenuation), the leveler circuit within the module is faulty;

if power is too high and the leveler at the negative rail (minimum attentuation), the level control circuit is increasing the output power by sending a bad control signal.

If the level control voltage is between the extremes of its range, but the output level is still incorrect, the fault is probably in the level control circuit (A5).

A failure of the leveler or other circuits in the RF module is unlikely, but can be caused by excessive reverse power applied at the instrument's RF output connnector.

5.3.7 Detector

The instrument's leveling system requires feedback from the RF path in order to control output power. This is provided by a negative-output diode detector, driven by a signal coupled from the RF output. The internal detector is mounted directly on the level coupler output of the RF module. An external detector can also be used, by attaching the cable from the external detector to the external ALC input on the rear panel.

CORRECTIVE ACTION

A failure of the internal detector itself is unlikely, but it is important to verify that the detector signal is in fact being received by the level control board (A5). When there is an apparent failure of the leveling system, disconnecting the detector cable and observing the resulting changes is often a revealing experiment.

Be sure that the correct levelling mode is activated (external ALC should not be enabled unless an external detector is in use).

5.3.8 Level Control Circuit

The level control circuit board (A5) is basically a loop amplifier which must balance a variable input (feedback from the level detector) against a reference signal. The detector can be either the internal detector mounted outside the RF module, or a remote detector (in the external ALC mode). The reference signal is derived from a combination of three inputs: the leveling reference programmed by the system computer, the correction signal from the temperature compensation circuit board (A112), and the AM signal, if any, from the modulation control board (A118). The level control circuit, using its output to drive the leveler in the RF module, adjusts output power in whichever direction will equalize the reference and variable inputs to the loop amplifier. So long as the output is between the extremes of its control range, the output is considered to be "leveled" and the indicator on the front panel will remain lit.

CORRECTIVE ACTION

If the 'LEVEL' indicator on the front panel is dark, the leveler output should be at one extreme or the other of its control range, and comparing the control signal with the result will indicate the nature of the problem (see 5.3.6 above). If the indicator is lit, the control signal should be within its control range, and if the output power is nevertheless incorrect, it is likely that the level control circuit is receiving a bad input, is defective, or has been incorrectly calibrated.

If possible, replace the level control circuit with a known good board. Make sure that the potentiometers on the board have not been improperly adjusted (see the calibration procedure in Section 4). Check all inputs and control signals to the board, including the input from the temperature compensation board, the data lines to the digital/analog converter, the AM input, the AM control line, and the detector input. Be sure that the instrument has not been set to the wrong leveling mode (if an external detector is not being used, external ALC should be off).

An excellent way to investigate a problem in the leveling system is to break the loop, by disconnecting the detector or the leveler control line, and observe the resulting changes.

5.3.9 Individual PLL Lock Indicators

Each of the six phase lock loop circuit boards has a lock indicator, in the form of an LED which is dark only for the "locked" condition.

CORRECTIVE ACTION

Determine which PLL or PLLs are unlocked. The relevant boards are:

A6 (output PLL)
A8 (40-80 MHz PLL)
A9 (intermediate PLL, Option 03)
A10 (10-12 MHz PLL Option 03)
A11 (300 MHz PLL)
A12 (110 MHz PLL)

If two or more loops are unlocked, it is possible that one unlocked loop is disabling "subsequent" loops which use the output of the first as a reference. The hierarchy of the loops, in terms of this dependency, may be divided into two branches terminating in the reference and variable inputs to the output PLL:

REFERENCE BRANCH	VARIABLE BRANCH
A12 (110 MHz PLL)	A12 (110 MHz PLL)
--option 03 only:	
--A10 (10-12 MHz PLL)	
--A9 (intermediate PLL)	A11 (300 MHz PLL)
A8 (40-80 MHz PLL)	
A6 (output PLL)	A6 (output PLL)

5.3.10 Output Phase Lock Loop

This circuit is located on the A6 PC board.

CORRECTIVE ACTION

Verify appropriate inputs from the divide-by-N circuit and the divide-by-8 circuit (see A7) and control line status (FM on/off).

The output to the FM driver (A103) goes more negative to increase the YIG output frequency, more positive to decrease frequency -- be sure that the PLL output is not driving the YIG oscillator in the wrong direction.

Verify that the output signal is reaching the FM driver, and that the driver's output is reaching the YIG oscillator FM coil and is being fed back to the output amplifier of the PLL.

If possible, replace the circuit with a known good board.

5.3.11 Divide-By-N

This circuit is one half of the frequency divider PC board (A7).

CORRECTIVE ACTION

Verify that the appropriate IF is being received from the 300 MHz oscillator circuit board (A104).

Verify that the circuit is being programmed with the correct divisor.

Verify that the IF is being correctly divided and that the output signal is reaching the output PLL (A6).

If possible, replace the circuit with a known good board.

5.3.12 300 MHz Oscillator

This circuit board (A104) is encased in an aluminum housing mounted on the microwave deck, directly beneath the RF module.

CORRECTIVE ACTION

This circuit is mounted in an inaccessible location; the most that can normally be done to investigate it in the field is to verify that the RF input from the RF module coupler, the two phase detector inputs from the 300 MHz PLL (A11), and the IF output to the divide-by-N (A7) are all present.

5.3.13 300 MHz PLL

This circuit is located on the A11 PC board.

CORRECTIVE ACTION

Verify appropriate inputs (from the 110 MHz oscillator/multiplier, 10 MHz master reference, and feedback from the 300 MHz oscillator) and control signals (from the computer).

Verify that the phase detector outputs for controlling the VCO are present and are reaching the 300 MHz oscillator.

If possible, replace the circuit with a known good board.

5.3.14 YIG Driver

This circuit is located on the A13 PC board.

CORRECTIVE ACTION

If this circuit is tuning the YIG oscillator to the wrong frequency, the error may be too large for the output PLL to correct. The problem sometimes occurs after incorrect adjustment of the "MIN" and "MAX" pots, in which case the output loop may be able to lock at some frequencies but not others. If the instrument develops phase lock problems after calibration of the YIG driver, try repeating the adjustment. Be sure to follow the correct calibration procedure as outlined in Section 4.

If the driver calibration is not to blame for the unlocked condition, attempts to adjust it may only aggravate the problem. Therefore, it is a good idea to determine first whether the driver output is approximately correct for the requested output frequency.

As described in 5.3.5 above, the oscillator tuning coil has a sensitivity of 20 MHz/mA. The NPN transistor which controls the coil current is driven at its base by a control voltage from the YIG driver. Because of large variations in coil impedence it is not possible to specify a "correct" voltage. However, it should be a positive voltage increasing with frequency at a rate of roughly 650 mV/GHz. A more exact idea of the coil current can be obtained from the voltage drop accross the sense resistor (see 5.3.5).

If the driver output seems substantially wrong, the cause could be bad control data to the digital/analog converter as well as bad calibration.

If possible, replace the circuit with a known good board.

5.3.15 110 MHz Oscillator/Multiplier

This circuit board (A113) is encased in an aluminum housing mounted on the underside of the microwave chassis.

CORRECTIVE ACTION

This circuit is mounted in an inaccessible location; the most that can normally be done to investigate it in the field is to verify that the tuning input is being received from the 110 MHz PLL (A12) and that the doubler and tripler outputs (220 and 330 MHz) are present and are reaching their destinations.

5.3.16 110 MHz PLL

This circuit is located on the A12 PC board.

CORRECTIVE ACTION

Verify that the 10 MHz master reference input is being received.

Verify that the 110 MHz input is being received.

If possible, replace the circuit with a known good board.

5.3.17 10 MHz Master Reference

The internal timebase is located between the front panel and the power supply; the 10 MHz input/output circuit is located on the 110 MHz PLL circuit board (A12).

CORRECTIVE ACTION

Verify that the signals from the internal timebase, and from the external timebase (if any), are being received by the 10 MHz input/output circuit.

Verify that the 10 MHz signal from the input/output circuit is reaching the various PLL circuits which require it.

5.3.18 Divide-By-8

This circuit is one-half of the frequency divider PC board (A7).

CORRECTIVE ACTION

Verify that the frequency input is being received from the 40-80 MHz PLL (A8).

Verify that the input is being divided by 8 and that the output signal is reaching the output PLL (A6).

If possible, replace the circuit with a known good board.

5.3.19 40-80 MHz PLL

This circuit is located on the A8 PC board.

CORRECTIVE ACTION

Verify that the 10 MHz input is being received from the master reference.

If option 03 is installed, verify that the 225-226 MHz input is being received from the intermediate PLL (A9). If option 03 is not installed, verify that the 220 MHz input is being received from the 110 MHz oscillator/mutliplier (A113).

Verify that the 40-80 MHz output is reaching the divide-by-8 circuit (A7).

If possible, replace the circuit with a known good board.

5.3.20 Intermediate PLL

This circuit is located on the A9 PC board. It is present only in instruments with option 03.

CORRECTIVE ACTION

Verify that the 220 MHz input is being received from the 110 MHz oscillator/multiplier (A113).

Verify that the 10-12 MHz input is being received from the 10-12 MHz PLL (A10).

Verify that the 225-226 MHz output is reaching the 40-80 MHz PLL (A8).

If possible, replace the circuit with a known good board.

5.3.21 10-12 MHz PLL

This circuit is located on the A10 PC board. It is present only in instruments with option 03.

CORRECTIVE ACTION

Verify that the 220 MHz input is being received from the 110 MHz oscillator/multiplier (A113).

Verify that the 10 MHz input is being received from the master reference.

Verify that the 10-12 MHz output is reaching the intermediate PLL.

If possible, replace the circuit with a known good board.

5.3.22 FM Driver

This circuit is located on the RF bus board, A103.

CORRECTIVE ACTION

Verify that the FM input signal is being received from the output PLL circuit (A6).

Verify that the output signal is reaching the YIG oscillator FM coil's negative terminal and is also being fed back to the output PLL. This output goes more negative to increase frequency, more positive to decrease.

5.3.23 Output Phase Lock Loop (FM)

This circuit is located on the A6 PC board.

CORRECTIVE ACTION

Verify that the FM input signal is being received from the modulation control board (A118).

Verify that the FM control line line is activating the FM mode.

Verify that the FM output signal is reaching the FM driver (A103) and that the driver output is being fed back to this circuit.

If possible, replace the circuit with a known good board.

5.3.24 Modulation Control (FM)

This circuit is located on the A118 PC board.

CORRECTIVE ACTION

Verify that all control inputs are appropriate to the FM mode selected (e.g., remote or local control, internal or external FM, etc.), and that an external modulation input (if applicable) is being received.

Verify that the FM output signal is reaching the output PLL (A6).

5.3.25 Leveler (AM)

The RF module's variable attenuator, described in 5.3.6 above, is used for amplitude modulation as well as for RF leveling.

CORRECTIVE ACTION

Verify that the control signal is being received from the level control circuit (A5). The control pin should go more positive to increase

attenuation, more negative to reduce attenuation.

5.3.26 Level Control Circuit (AM)

This circuit is located on the A5 PC board.

CORRECTIVE ACTION

Verify that the AM input signal is being received from the modulation control board (A118) and that the AM mode is being selected by the control input.

Verify that the AM signal is present on the output to the leveler.

If possible, replace the circuit with a known good board.

5.3.27 Modulation Control (AM)

This circuit is located on the A118 PC board.

CORRECTIVE ACTION

Verify that all control inputs are appropriate to the AM mode selected (e.g., remote or local control, internal or external AM, etc.), and that an external modulation input (if applicable) is being received.

Verify that the AM output signal is reaching the level control board (A5).

5.3.28 Modulator

The RF module's filter select/modulation lines, described in 5.3.4 above, are used for pulse modulation.

CORRECTIVE ACTION

Verify that the filter select/modulation control pin which is active for the requested output frequency has positive pulses corresponding with the "off" periods of the instrument's RF output; these should be received from the modulation control board (A118).

5.3.29 Modulation Generator (Pulse Modulation)

This circuit is located on the A118 PC board.

CORRECTIVE ACTION

Verify that all control inputs are appropriate to the pulse mode selected (e.g., remote or local control, internal or external trigger, etc.), and that an external modulation input (if applicable) is being received.

Verify that the modulation output is reaching the appropriate pulse modulator pin on the RF module.

5.3.30 YIG Driver Board

This circuit is located on the A13 PC board.

CORRECTIVE ACTION

The sweep process is implemented through modification of the YIG driver's output control signal. A fault in this circuit may cause the instrument to sweep at the wrong rate, over the wrong range, or not at all. In the analog sweep mode, verify that the sweep DAC is receiving the required voltage ramp from the analog sweep boards (A24/A25). In the digital sweep mode, the sweep DAC should not be active (the sweep steps are implemented through programming of the primary DAC). Verify that the DACs are receiving appropriate command signals from the computer. Be sure that the potentiometer on the output of the sweep DAC is not out of calibration. If possible, replace the circuit with a known good board.

5.3.31 Analog Sweep Boards

These circuits, located on the A24 and A25 PC boards, may be considered functionally as a single circuit which produces sweep ramps, markers, and other signals necessary to analog sweep operation.

CORRECTIVE ACTION

The analog sweep circuit requires control signals from the computer and from the sweep clock/frequency hold board (A27). Verify that the circuit is receiving the required signals, and is furnishing the necessary outputs to the YIG driver circuit (A13) and to the front and rear panels. If possible, replace with known good boards.

5.3.32 Sweep Clock/Frequency Hold Board

This circuit is located on the A27 PC board. Its generates a clock signal and other trigger signals used by the analog sweep boards. The board also contains a sample-and-hold circuit used in conjunction with the output PLL circuit during an analog sweep.

CORRECTIVE ACTION

Verify that the needed control signals are being received from the computer and from the front panel. Verify continuity of the input/output lines with the analog sweep boards (A24/A25) and with the output PLL (A6). If possible, replace with a known good board.

5.3.33 Downconverter/Level Correction Board

This circuit is located on the A26 board. In Model 610 this board is not associated with the downconverter; the title is a vestige of the board's use in another instrument. The circuit produces a level correction signal for use in the analog sweep mode, and also produces the control signals by which filter lines are activated.

CORRECTIVE ACTION

Verify that the circuit is receiving all of its control inputs from the computer, and that the output correction signal is reaching the level control circuit (A7). If possible, replace with a known good board.

5.3.34 GPIB Address

The DIP switches which set the address are located on the A111 PC board, which is mounted at the rear panel.

CORRECTIVE ACTION

Verify that the address assigned to the instrument by the GPIB bus controller is properly set (in the form of a 5-place binary number) by the five switches located on the rear panel. If the address is set incorrectly, the instrument will ignore all IEEE-488 commands.

5.3.35 Commands

Section 1 of the manual includes a full description of the syntax and commands appropriate to the operation of Model 610 under remote control using the IEEE-488 interface bus. Be sure that any remote commands issued to the instrument conform to the guidelines set out in that description.

5.3.36 IEEE-488 Interface Circuit

This circuit is found on the A3 PC board.

CORRECTIVE ACTION

Verify that this circuit's data and control lines have continuity to the rear panel connector and to the CPU. If possible, replace the circuit with a known good board.

5.4 ELECTRICAL INTERCONNECTIONS WITHIN MODEL 610

Most of the instrument's circuits are housed in replaceable plug-in modules; connections between these circuits are made by means of wires, ribbon cables, and bus-board traces. This list of interconnections is provided for purposes of continuity checking and circuit study.

5.4.1 Computer Bus (A0 through A5)

Circuit boards A0 through A5 are inserted in the computer bus board (A102), which includes several headers (P1, P2 etc.) for ribbon connectors. PC boards A1-A5 have three edge-connectors: J1 (34 pins), J2 (60 pins), and J3 (26 pins). Even numbers designate pins on the solder side of the board, odd numbers designate pins on the component side.

The computer, RF, and sweep bus boards contain printed traces which provide connections between the circuits mounted on them. Other circuits are mounted independently and are interconnected by wires, coaxial cables, and ribbon cables. Since pin numbering is the same at each end of a ribbon connector, pins connected in this way are batch-listed (e.g., A102-P8 PINS 1-26 to A124-P1 PINS 1-26), with independent connections shown below the batch listing.

A0 -- GENERAL PURPOSE PIA (J1 = 34 PINS, J2 = 60 PINS, J3 = 26 PINS)

from:	to:	notes:
(RIBBON)*		
A0 J1 PINS 1-34	A102 P7 PINS 1-34	FROM CPU BUS TO PUSHBUTTON
**********	A123 P1 PINS 1-34	SWITCHES
A0-J2-1 THRU -4	GND	
A0-J2-11 THRU -50	A1-J2-11 THRU -50 ETC	MICROPROCESSOR CTRL BUS
A0-J2-52	A24-A-23 & A25-B-27 & A26-A-18 & A124-19	DATA 7
A0-J2-53	A124-25 & A27-A-11	PEN LIFT EN
A0-J2-54	A24-A-23 & A25-A-25 & A26-A-19 & A124-27	DATA 6
A0-J2-55	A24-A-22 & A25-B-22 & A26-A-20 & A124-16	DATA 5
A0-J2-56	A24-A-21 & A25-A-22 & A26-B-18 & A124-28	DATA 3
A0-J2-57 THRU -60	+5 SUPPLY	
(RIBBON)*		
A0 J3 PINS 1-26	A102 P8 PINS 1-26	FROM CPU BUS TO SWEEP BUS
**********	& A124 P1 PINS 1-26	
OTHER CONNECTIONS		
A0-J3-1	A13-K & A24-A-6 & A26-B-6 & A26-B-7 & A27-B-10 & A124-10	SWEEP RESET
A0-J3-3	A24-B-22 & A25-B-21 & A26-A-21	DATA 4

A0-J3-4	A4-J3-5 & A124-18	BAND RESET
A0-J3-5	A24-A-8 & A25-A-27 & A26-A-26	WRITE-NOT/READ
A0-J3-6	A27-A-13	RESET FMC MEM
A0-J3-7	A24-B-20 & A25-A-28 & A26-B-21	DATA 0
A0-J3-8	A27-A-7	START/REC-NOT
A0-J3-9	A24-B-21 & A25-A-23 & A26-B-19	DATA 2
A0-J3-10	A24-A-20 & A25-B-26 & A26-B-20	DATA 1
A0-J3-11	A24-B-9 & A26-A-17	ADDR 15
A0-J3-12	A24-A-12 & A26-B-11	ADDR 7
A0-J3-13	A24-B-11 & A26-B-13	ADDR 6
A0-J3-14	A24-A-9 & A26-A-16	ADDR 14
A0-J3-15	A24-B-10 & A26-B-16	ADDR 13
A0-J3-16	A24-A-10 & A26-A-15	ADDR 12
A0-J3-17	A24-B-12 & A26-B-14	ADDR 5
A0-J3-18	A24-B-16 & A26-A-9	ADDR 11
A0-J3-19	A24-A-13 & A26-B-12	ADDR 4
A0-J3-20	A24-B-14 & A26-B-9	ADDR 8
A0-J3-21	A24-A-11 & A26-A-14	ADDR 0
A0-J3-22	A24-A-15 & A26-A-11	ADDR 9
A0-J3-23	A24-B-13 & A26-A-13	ADDR 1
A0-J3-24	A24-A-16 & A26-A-10	ADDR 10
A0-J3-25	A24-A-14 & A26-A-12	ADDR 2
A0-J3-26	A24-B-15 & A26-B-10	ADDR 3

A1 -- DISPLAY PIA (J1 = 34 PINS, J2 = 60 PINS, J3 = 26 PINS)

from:	to:	notes:
A1-J1-2	A102-P5-18	DDF 1
A1-J1-3	A102-P5-10	FSEG h
A1-J1-4	A102-P5-5	FSEG e
A1-J1-5	A102-P5-8	DDF 0
A1-J1-6	A102-P5-7	FSEG d
A1-J1-7	A102-P5-4	FSEG f
A1-J1-8	A102-P5-13	DDF 2
A1-J1-9	A102-P5-16	FSEG c
A1-J1-10	A102-P5-14	DDF 3
A1-J1-11	A102-P5-15	FSEG b
A1-J1-12	A102-P5-11	DDF 4
A1-J1-13	A102-P5-3	DDF 7
A1-J1-14	A102-P5-12	DDF 5
A1-J1-15	A102-P5-17	FSEG a
A1-J1-16	A102-P5-9	DDF 6
A1-J1-17	A13-19	RATE 2
A1-J1-18	A13-W	RATE 1
A1-J1-21	A102-P4-22	DDP 2
A1-J1-22	A102-P5-6	FSEG y
A1-J1-23	A102-P4-25	PSEG t
A1-J1-24	A102-P4-18	DDP 0
A1-J1-25	A102-P4-8	PSEG c

A1-J1-26	A102-P4-16	PSEG y
A1-J1-27	A102-P4-26	DDP4
A1-J1-28	A102-P4-14	PSEG f
A1-J1-29	A102-P4-4	PSEG a
A1-J1-30	A102-P4-20	DDP 1
A1-J1-31	A102-P4-6	PSEG b
A1-J1-32	A102-P4-12	PSEG e
A1-J1-33	A102-P4-24	DDP 3
A1-J1-34	A102-P4-10	PSEG d
A1-J2-1 THRU -4	J2-1 THRU J2-4, A0 THRU A5	GND
A1-J2-11 THRU -50	J2-11 THRU J2-50, A0 THRU A4	MICROPROCESSOR CTRL BUS
A1-J2-53 & -54	J2-53 & -54, A2 THRU A5	-18 SUPPLY
A1-J2-55 & -56	A2-55 & -56, A2 THRU A5	+18 SUPPLY
A1-J2-57 THRU -60	J2-57 THRU -60, A2 THRU A5	+5 SUPPLY
A1-J3-1	A102-P2-4	TWS D4
A1-J3-2	A102-P2-3	TWS D8
A1-J3-3	A102-P2-6	TWS D1
A1-J3-4	A102-P2-5	TWS D2
A1-J3-5	A102-P2-8	TWS STB C
A1-J3-6	A102-P2-7	TWS STB D
A1-J3-7	A102-P2-10	TWS STB A
A1-J3-8	A102-P2-9	TWS STB B
A1-J3-10	A102-P3-14	
A1-J3-11	A102-P2-11	SPARE
A1-J3-14	A102-P3-13	
A1-J3-15	A13-L & A13-7	FAST
A1-J3-16	A102-P3-12	
A1-J3-17	A102-P2-17 & A124-13 & A27-B-14	C BLANK
A1-J3-18	A102-P3-11	
A1-J3-19	A102-P2-19 & A24-A-24 & A124-20	MARKER READ/NOT
A1-J3-20	A102-P4-28	(+) SIGN
A1-J3-21	A124-11 & A27-B7	EXT TRIG EN
A1-J3-22	A102-P1-22 & A124-6 & A26-A-24 & A27-A24	DNCNV FILTER 2
A1-J3-23	A25-A-12 & A124-8	NARROW SWEEP/NOT
A1-J3-24	A102-P1-24 & A124-22 & A26-A-23 & A27-A-23	DNCNV FILTER 1
A1-J3-26	A102-P1-26 & A124-21 & A1-J3-26	DNCNV FILTER 0

A2 -- MEMORY (J2 = 60 PINS)

from:	to:	notes:
A2-J2-1 THRU -4	GND	SEE A1 J2
A2-J2-11 THRU -50	MICROPROCESSOR CTRL BUS	SEE A1 J2
A2-J2-53 & -54	-18 SUPPLY	SEE A1 J2
A2-J2-55 & -56	+18 SUPPLY	SEE A1 J2
A2-J2-57 THRU -60	+5 SUPPLY	SEE A1 J2

A3 -- IEEE PIA (J1 = 34 PINS, J2 = 60 PINS, J3 = 26 PINS)

from:	to:	notes:
A3-J1-1	A102-P6-2 & INTFC ADDRESS	DEVICE ADDRESS BIT A4
A3-J1-2	A102-P6-1 & INTFC ADDRESS	GND
A3-J1-3	A102-P2-4 & INTFC ADDRESS	DEVICE ADDRESS BIT A3
A3-J1-4	A102-P2-3 & INTFC ADDRESS	GND
A3-J1-5	A102-P2-6 & INTFC ADDRESS	DEVICE ADDRESS BIT A2
A3-J1-6	A102-P6-5 & INTFC ADDRESS	GND
A3-J1-7	A102-P6-8 & INTFC ADDRESS	DEVICE ADDRESS BIT A1
A3-J1-8	A102-P6-7 & INTFC ADDRESS	GND
A3-J1-9	A102-P6-10 & INTFC ADDRESS	DEVICE ADDRESS BIT A0
A3-J1-10	A102-P6-9 & INTFC ADDRESS	GND
A3-J1-11	A102-P6-12 & REMOTE	SHIELD PIN 12
A3-J1-12	A102-P6-11 & REMOTE	GND PIN 24
A3-J1-13	A102-P6-14 & REMOTE	ATN PIN 11
A3-J1-14	A102-P6-13 & REMOTE	GND PIN 23
A3-J1-15	A102-P6-16 & REMOTE	SRQ PIN 10
A3-J1-16	A102-P6-15 & REMOTE	GND PIN 22
A3-J1-17	A102-P6-18 & REMOTE	IFC PIN 9
A3-J1-18	A102-P6-17 & REMOTE	GND PIN 21
A3-J1-19	A102-P6-20 & REMOTE	NDAC PIN 8
A3-J1-20	A102-P6-19 & REMOTE	GND PIN 20
A3-J1-21	A102-P6-22 & REMOTE	NRFD PIN 7
A3-J1-22	A102-P6-21 & REMOTE	GND PIN 19
A3-J1-23	A102-P6-24 & REMOTE	DAV PIN 6
A3-J1-24	A102-P6-23 & REMOTE	GND PIN 18
A3-J1-25	A102-P6-26 & REMOTE	EOI PIN 5
A3-J1-26	A102-P6-25 & REMOTE	REN PIN 17
A3-J1-27	A102-P6-28 & REMOTE	D104 PIN 4
A3-J1-28	A102-P6-27 & REMOTE	D108 PIN 16
A3-J1-29	A102-P6-30 & REMOTE	D103 PIN 3
A3-J1-30	A102-P6-29 & REMOTE	D107 PIN 15
A3-J1-31	A102-P6-32 & REMOTE	D102 PIN 2
A3-J1-32	A102-P6-31 & REMOTE	D106 PIN 14
A3-J1-33	A102-P6-34 & REMOTE	D101 PIN 1
A3-J1-34	A102-P6-33 & REMOTE	D105 PIN 13
A3-J2-1 THRU -4	GND	SEE A1 J2
A3-J2-11 THRU -50	MICROPROCESSOR CTRL BUS	SEE A1 J2
A3-J2-53 & -54	-18 SUPPLY	SEE A1 J2
A3-J2-55 & -56	+18 SUPPLY	SEE A1 J2
A3-J2-57 THRU -60	+5 SUPPLY	SEE A1 J2
A3-J3-3	A5-J3-3 & A102-P1-3	DAC D0
A3-J3-5	A5-J3-6 & A102-P1-6	DAC D1
A3-J3-6	A5-J3-5 & A102-P1-5	DAC D2
A3-J3-7	A5-J3-8 & A102-P1-8	DAC D3
A3-J3-8	A5-J3-7 & A102-P1-7	DAC A0
A3-J3-9	A5-J3-9 & A102-P1-10	DAC A1
A3-J3-10	A102-P1-9	DAC A2
A3-J3-11	A102-P1-12 & A7-K	DIV A
A3-J3-12	A5-J3-11, A102-P1-11, & A13-R/14	DAC WR/NOT

A3-J3-13	A102-P3-15 & A124-14 & A26-A-25	DC FIL 3
A3-J3-14	A102-P1-13 & A7-L	DIV B
A3-J3-18	A13-J	>=2
A3-J3-19	A102-P1-15	SEL/NOT 7
A3-J3-20	A102-P1-17	SEL/NOT 0
A3-J3-21	A102-P1-19	SEL/NOT 4
A3-J3-22	A5-J3-10	SEL/NOT 1
A3-J3-23	A102-P1-21	SEL/NOT 5
A3-J3-25	A102-P1-23	SEL/NOT 6
A3-J3-26	A102-P1-25	SEL/NOT 3

A4 -- CPU (J2 = 60 PINS, J3 = 26 PINS)

from:	to:	notes:
A4-J2-1 THRU 4	GND	SEE A1 J2
A4-J2-11 THRU -50	MICROPROCESSOR CTRL BUS	SEE A1 J2
A4-J2-53 & -54	-18 SUPPLY	SEE A1 J2
A4-J2-55 & -56	+18 SUPPLY	SEE A1 J2
A4-J2-57 THRU -60	+5 SUPPLY	SEE A1 J2
A4-J3-1	A124-1 & A27-A-8 & F.P. SWP SYNC TRIG BNC	SWEEP SYNC TRIG
A4-J3-2	A102-P1-2 & A12-6	LOCK (110 PLL)
A4-J3-3	A102-P1-4 & A8-H	LOCK (40-80 PLL)
A4-J3-4	A102-P1-1 & A10-F & A9-H	LOCK (INT + HI RES PLLS)
A4-J3-5	A0-J3-4 & A124-18	BAND RESET
A4-J3-6	A102-P1-14 & A11-Y	LOCK (300 PLL)
A4-J3-14	A5-J3-13	STEP ATTEN 0
A4-J3-15	A102-P4-27	LEVEL LED
A4-J3-16	A5-J3-15	STEP ATTEN 1
A4-J3-17	A102-P3-16 & -P5-23	REM LED
A4-J3-18	A5-J3-17	STEP ATTEN 2
A4-J3-19	A102-P1-16 & A6-20	LOCK (OUTPUT PLL)
A4-J3-20	A5-J3-19	STEP ATTEN 3
A4-J3-21	A5-J3-4	LEVEL DET/NOT
A4-J3-22	A102-P5-24	LOCK LED

A5 -- LEVEL CONTROL (J1 = 34 PINS, J2 = 60 PINS, J3 = 26 PINS)

from:	to:	notes:
A5-J1-1 & -2	A102-1 OR A102 J4-6	STEP ATTEN: +24V (red)
A5-J1-3	A102-2 OR A102 J4-2	STEP ATTEN: 10 ON (yel)
A5-J1-5	A102-3 OR A102 J4-13	STEP ATTEN: 10 OFF (vio)
A5-J1-7	A102-4 OR A102 J4-11	STEP ATTEN: 20 OFF (blk)
A5-J1-9	A102-5 OR A102 J4-5	STEP ATTEN: 20 ON (grn)
A5-J1-11	A102-6 OR A102 J4-3	STEP ATTEN: 40 OFF #1 (ora)
A5-J1-13	A102-7 OR A102 J4-9	STEP ATTEN: 40 ON #1 (blu)
A5-J1-15	A102-8 OR A102 J4-4	STEP ATTEN: 40 OFF #2 (brn)
A5-J1-17	A102-9 OR A102 J4-10	STEP ATTEN: 40 ON #2 (wht)
A5-J1-20	A6-19	FM SIGNAL
A5-J1-22	A5-J2-18	AM SIGNAL

A5-J1-24	A102-P4-11	FM
A5-J1-27	A102-P4-3	U8 Q0
A5-J1-28	A102-P4-23	U8 DS4
A5-J1-29	A102-P4-5	U8 Q1
A5-J1-30	A102-P4-21	U8 DS3
A5-J1-31	A102-P4-7	U8 Q2
A5-J1-32	A102-P4-19	U8 DS2
A5-J1-33	A102-P4-9	U8 Q3
A5-J1-34	A102-P4-17	U8 DS1
A5-J2-1 THRU -4	GND	SEE A1 J2
A5-J2-6	A102-P3-4	A102 -5.2V
A5-J2-28	GND	
A5-J2-30	A102-P1-18	SEL AM
A5-J2-32	A3-J3-16 & A117-5	SEL EXT ALC
A5-J2-34	A117-3	EXT DET
A5-J2-36	A117-2	EXT O.S.
A5-J2-38	DETECTOR	
A5-J2-53 & -54	-18 SUPPLY	SEE A1 J2
A5-J2-55 & -56	+18 SUPPLY	SEE A1 J2
A5-J2-57 THRU -60	+5 SUPPLY	SEE A1 J2
A5-J3-1	GND	
A5-J3-2	RF MODULE LEVEL PIN	LEVELING CONTROL SIGNAL
A5-J3-3	A3-J3-3 & A102-P1-3	DAC D0
A5-J3-5	A3-J3-6 & A102-P1-5	DAC D2
A5-J3-4	A4-J3-21	LEVEL DET/NOT
A5-J3-6	A3-J3-5 & A102-P1-6	DAC D1
A5-J3-7	A3-J3-8 & A102-P1-7	DAC A0
A5-J3-8	A3-J3-7 & A102-P1-8	DAC D3
A5-J3-9	A3-J3-9 & A102-P1-10	DAC A1
A5-J3-11	A3-J3-12 & A102-P1-11 & A13-R/14	DAC WR/NOT
A5-J3-15	A4-J3-16	STEP ATTEN 1
A5-J3-17	A4-J3-18	STEP ATTEN 2
A5-J3-19	A4-J3-20	STEP ATTEN 3
A5-J3-24	A112 OUT	INPUT FROM TEMP COMP CKT
A5-J3-26	A124-7 & A26-A-27	LEVEL CORR

5.4.2 RF Bus (A6 through A13)

Circuit boards A6 through A13 are inserted into the RF bus board, A103, which includes two headers (P1 and P2) for ribbon connectors. PC boards A6 through A13 have single 44-pin edge connectors (letters A-Z designate pins on the solder side of the board, numbers 1-22 designate pins on the component side).

Several pairs of pins on circuit boards A6 through A13 are tied together, and are connected to the equivalent pins on most or all of the other boards. The table on the following page specifies how the pins are held in common.

Additional connections involving the RF bus board itself, rather than circuit boards A6 through A13, are listed under A103.

PINS:	PC BOARDS:	A103 CONNECTORS:	NOTES:
1/A & 22/Z	A6-A13	P2-9/10	DIGITAL GND
2/B	A6-A13		+5V
3/C	A6-A13	P2-5/6	-18V
4/D	A6-A13	P2-3/4	-5.2V
5/E	A6-A13	P2-1/2	+18V
11/M	A6-A13	P1-3	D0
12/N	A6-A13	P1-6	D1
13/P	A6-A13	P1-7	A0
14/R	A6 thru A12 only	P1-9	WR/NOT
16/T	A6-A13	P1-10	A1
17/U	A6-A13	P1-8	D3
18/V	A6-A13	P1-5	D2

A6 -- OUTPUT PLL (44-pin connector, 1-22 & A-Z)

from:	to:	notes:
A6-6	A103 P1-20, & A102 P1-20	FM ON
A6-7	A103 R7	FROM FM DRIVER
A6-8	A7-H	5-10 MHZ IN (REF)
A6-9	A7-J	5-10 MHZ IN (REF)
A6-19	A5-J1-20 & A105-9	FM IN
A6-20	A103 P1-16 & A102 P1-16 & A105 P3-16 & A4 J3-19	LOCK
A6-21	A124-4 & A27-B-13	
A6-F	A124-12 & A27-B-12	
A6-H	A124-3 & A27-B-11	READY
A6-K	A7-X	5-10 MHZ IN (VAR)
A6-L	A7-Y	5-10 MHZ IN (VAR)
A6-Y	A103 CR11/CR12	TO FM DRIVER

A7 -- DIVIDER (44-pin connector, 1-22 & A-Z)

from:	to:	notes:
A7-H	A6-8	5-10 OUT (40-80 MHZ/8)
A7-J	A6-9	5-10 OUT (40-80 MHZ/8)
A7-K	A103 P1-12 & A102 P1-12 & A3 J3-11	DIV A
A7-L	A103 P1-13 & A102 P1-13 & A3 J3-14	DIV B
A7-X	A6-K	5-10 OUT (I.F./N)
A7-Y	A6-L	5-10 OUT (I.F./N)
A7-J1	A104-J3	I.F. IN
A7-J2	A8-J1	40-80 MHZ IN

A8 -- 40-80 PLL (44-pin connector, 1-22 & A-Z)

from:	to:	notes:
A8-H	A103 P1-4 & A102 P1-4 & A4 J3-3	LOCK
A8-K	A12-L	10 MHZ IN
A8-L	A12-10	10 MHZ IN
A8-S	A103 U1-4	SEL6
A8-J1	A7-J2	40-80 OUT
A8-J2	A9-J1 [OPTION 03 ONLY]	225-226 REF IN
OR:	A113-J1 [DELETE FOR OPT. 03]	220 REF IN

A9 -- INTERMEDIATE PLL [OPTION 03 ONLY] (44-pin connector, 1-22 & A-Z)

from:	to:	notes:
A9-19	A10-Y	
A9-22	A113 GND LUG	GND
A9-H	A10-F & A103 P1-1 & A102 P1-1 & A4 J3-4	LOCK
A9-W	A10-X	10-12 MHZ IN
A9-Y	A113-J3	220 MHZ IN
A9-J1	A8-J2	225-226 MHZ OUT

A10 -- HIGH RESOLUTION [OPTION 03 ONLY] (44-pin connector, 1-22 & A-Z)

from:	to:	notes:
A10-F	A9-H & A103 P1-1 & A102 P1-1 & A4 J3-4	LOCK
A10-K	A12-8	10 MHZ IN
A10-L	A12-J	GND
A10-S	A103 U1-3	SEL5
A10-X	A9-W	10-12 MHZ OUT
A10-Y	A9-19	10-12 MHZ OUT
A10-J1	A113-J1	220 MHZ IN

A11 -- 300 MHz PLL (44-pin connector, 1-22 & A-Z)

from:	to:	notes:
A11-K	A12-9	10 MHZ IN
A11-L	A12-K	GND
A11-S	A103 U1-10	SEL7
A11-W/X	A104-J2	TUNE
A11-Y	A103 P1-14 & A102 P1-14 & A4 J3-6	LOCK
A11-J1	A113-J6	284-319 MHZ OUT
A11-J2	A104-J1	330 MHZ IN

A12--304CA05600, 110 MHz PLL (44-pin connector, 1-22 & A-Z)

from:	to:	notes:
A12-6	A102 P1-2 & A4 J3-2	LOCK
A12-8	A10-K	10 MHZ OUT
A12-9	A11-K	10 MHZ OUT
A12-10	A8-L	10 MHZ OUT
A12-21	'10 MHz IN'	REAR PANEL BNC
A12-F	A113 J5	TUNE
A12-H	A113 J4	110 MHZ IN
A12-J	A10-L	10 MHZ OUT
A12-K	A11-L	10 MHZ OUT
A12-L	A8-K	10 MHZ OUT
A12-S	A114-1 (TCXO)	DELETE FOR OPTION 06
	OR: HI STAB OSC 4	OPTION 06 ONLY
A12-W	HI STAB OSC 3	OPTION 06 ONLY
A12-X	A114-4 (TCXO)	DELETE FOR OPTION 06
A12-Y	'10 MHz OUT'	REAR PANEL BNC

A13 -- YIG DRIVER (44-pin connector, 1-22 & A-Z)

from:	to:	notes:
A13-7	A1-J3-15 & A13-L	FAST
A13-14/R	A103 U1-9 & A103 P1-11 & A102-P-11 & A3-J3-12	DAC WR/NOT
A13-19	A1-J1-17	RATE 2
A13-20	YIG ASSY R-sense P1	
A13-F	YIG ASSY R-sense P2	
A13-H	A124-24 & A25-A-11	YIG RAMP
A13-J	A3-J3-18	>=2
A13-K	A0-J3-1 ETC	SWEEP RESET
A13-L	A1-J3-15 & A13-7	FAST
A13-S	A103-P1-17 & A102-P1-17	SEL/NOT 0
A13-W	A1-J1-18	RATE 1
A13-X	YIG ASSY XSTR-B	
A13-Y	YIG OSC TUNE (+)	

5.4.3 Sweep Bus (A24 through A27)

Circuit boards A24 through A27 are inserted in the sweep bus board (A124), which includes a header (P1) for a ribbon connector and a group of numbered wiring holes. PC boards A24-A27 have single 60-pin edge connectors (numbers A1 through A30 designate pins on the solder side of the board, numbers B1 through B30 designate pins on the component side of the board).

A24 -- ANALOG SWEEP NO. 2 (60-pin connector, A1-A30 & B1-B30)

from:	to:	notes:
A24-A-1	A24-B-4 & GND	RECURRENT RESET
A24-A-2	-15 SUPPLY	
A24-A-3	+15 SUPPLY	
A24-A-4	A25-A-9	RFB
A24-A-5	A27-B-9	BAND RESET
A24-A-6	A0-J3-1 ETC	SWEEP RESET
A24-A-7	A25-B-12	RESET
A24-A-8	A0-J3-5 ETC	W-NOT/R
A24-A-9	A0-J3-14 ETC	ADDR 14
A24-A-10	A0-J3-16 ETC	ADDR 12
A24-A-11	A0-J3-21 ETC	ADDR 0
A24-A-12	A0-J3-12 ETC	ADDR 7
A24-A-13	A0-J3-19 ETC	ADDR 4
A24-A-14	A0-J3-25 ETC	ADDR 2
A24-A-15	A0-J3-22 ETC	ADDR 9
A24-A-16	A0-J3-24 ETC	ADDR 10
A24-A-17	A26-B-8 ETC	CLOCK/4
A24-A-20	A0-J3-10 ETC	DATA 1
A24-A-21	A0-J2-56 ETC	DATA 3
A24-A-22	A0-J2-55 ETC	DATA 5
A24-A-23	A0-J2-52 ETC	DATA 7
A24-A-24	A1-J3-19 & A124-20	MARKER READ/NOT
A24-A-25	A25-B-23	M/NOT
A24-A-29	+5 SUPPLY	
A24-A-30	GND	
A24-B-1	GND	
A24-B-2	A25-B-10	RF U7
A24-B-3	A25-A-10	OUT U7
A24-B-4	A24-A-1 & GND	RECURRENT RESET
A24-B-5	A25-A-15 & A26-A-8	CLOCK/NOT
A24-B-6	A25-B-25	CS0/NOT
A24-B-7	A25-A-26	CS1/NOT
A24-B-8	A25-A-24	CS2/NOT
A24-B-9	A0-J3-11 ETC	ADDR 15
A24-B-10	A0-J3-15 ETC	ADDR 13
A24-B-11	A0-J3-13 ETC	ADDR 6
A24-B-12	A0-J3-17 ETC	ADDR 5
A24-B-13	A0-J3-23 ETC	ADDR 1
A24-B-14	A0-J3-20 ETC	ADDR 8
A24-B-15	A0-J3-26 ETC	ADDR 3
A24-B-16	A0-J3-18 ETC	ADDR 11
A24-B-20	A0-J3-7 ETC	DATA 0
A24-B-21	A0-J3-9 ETC	DATA 2
A24-B-22	A0-J3-3 ETC	DATA 4
A24-B-23	A0-J2-54 ETC	DATA 6
A24-B-25	A27-A-26 & A25-B-24	OE/NOT
A24-B-26	A25-A-20	OUT U5
A24-B-27	A25-A-19	RF U5
A24-B-30	GND	

A25 -- ANALOG SWEEP NO. 1 (60-pin connector, A1-A30 & B1-B30)

from:	to:	notes:
A25-A-1	GND	
A25-A-2	-15 SUPPLY	
A25-A-3	+15 SUPPLY	
A25-A-4	-5.2 SUPPLY	
A25-A-5	+15 SUPPLY	
A25-A-8	A124-17 & REAR PANEL BNC	.5V/GHZ OUTPUT BNC
A25-A-9	A24-A-4	RFB
A25-A-10	A24-B-3	OUT U7
A25-A-11	A124-24 & A13-H	YIG RAMP
A25-A-12	A1-J3-23	NARROW SWEEP/NOT
A25-A-14	A27-A-6	BAND END
A25-A-15	A24-B-5 & A26-A-8	CLOCK/NOT
A25-A-16	A26-A-7 & A27-A-9	UNBLANK
A25-A-17	A124-9 & REAR PANEL BNC	UNBLANK/MARKER
A25-A-18	A27-A-10	CLOCK
A25-A-19	A24-B-27	RF U5
A25-A-20	A24-B-26	OUT U5
A25-A-21	A25-B-17	MOE
A25-A-22	AO-J2-56 ETC	DATA 3
A25-A-23	AO-J3-9 ETC	DATA 2
A25-A-24	A24-B-8	CS2/NOT
A25-A-25	AO-J2-54 ETC	DATA 6
A25-A-26	A24-B-7	CS1/NOT
A25-A-27	AO-J3-5 ETC	W-NOT/R
A25-A-28	AO-J3-7 ETC	DATA 0
A25-A-29	+5 SUPPLY	
A25-A-30	GND	
A25-B-1	GND	
A25-B-10	A24-B-2	RF U7
A25-B-11	+5 SUPPLY	EXTENDER/NOT
A25-B-12	A24-A-7	RESET
A25-B-13	+5 SUPPLY	SWEEP
A25-B-14	A27-A-25	SWEEP OUT
A25-B-17	A25-A-21	MOE
A25-B-21	AO-J3-3 ETC	DATA 4
A25-B-22	AO-J2-55 ETC	DATA 5
A25-B-23	A24-A-25	M/NOT
A25-B-24	A27-A-26 & A24-B-25	OE/NOT
A25-B-25	A24-B-6	CSO/NOT
A25-B-26	AO-J3-10 ETC	DATA 1
A25-B-27	AO-J2-52 ETC	DATA 7
A25-B-30	GND	

A26 -- DOWNCONVERTER/LEVEL CORRECTION (60-pin connector, A1-A30 & B1-B30)

from:	to:	notes:
A26-A-1	GND	
A26-A-2	-15 SUPPLY	
A26-A-3	+15 SUPPLY	

A26-A-7	A25-A-16 & A27-A-9	UNBLANK
A26-A-8	A24-B-5 & A25-A-15	CLOCK/NOT
A26-A-9	AO-J3-18 ETC	ADDR 11
A26-A-10	AO-J3-24 ETC	ADDR 10
A26-A-11	AO-J3-22 ETC	ADDR 9
A26-A-12	AO-J3-25 ETC	ADDR 2
A26-A-13	AO-J3-23 ETC	ADDR 1
A26-A-14	AO-J3-21 ETC	ADDR 0
A26-A-15	AO-J3-16 ETC	ADDR 12
A26-A-16	AO-J3-14 ETC	ADDR 14
A26-A-17	AO-J3-11 ETC	ADDR 15
A26-A-18	AO-J2-52 ETC	DATA 7
A26-A-19	AO-J2-54 ETC	DATA 6
A26-A-20	AO-J2-55 ETC	DATA 5
A26-A-21	AO-J3-3 ETC	DATA 4
A26-A-22	A1-J3-26 & A124-21	DNCNV FILTER 0
A26-A-23	A1-J3-24 & A27-A-23	DNCNV FILTER 1
A26-A-24	A1-J3-22 & A27-A-24	DNCNV FILTER 2
A26-A-25	A3-J3-13 & A124-14	DNCNV FILTER 3
A26-A-26	AO-J3-5 ETC	W-NOT/R
A26-A-27	A5-J3-26 & A124-7	LEVEL CORR
A26-A-28	+5 SUPPLY	
A26-A-29	+5 SUPPLY	
A26-A-30	GND	
A26-B-1	GND	
A26-B-6	AO-J3-1 ETC	SWEEP RESET
A26-B-7	AO-J3-1 ETC	SWEEP RESET
A26-B-8	A24-A-17	CLOCK/4
A26-B-9	AO-J3-20 ETC	ADDR 8
A26-B-10	AO-J3-26 ETC	ADDR 3
A26-B-11	AO-J3-12 ETC	ADDR 7
A26-B-12	AO-J3-19 ETC	ADDR 4
A26-B-13	AO-J3-13 ETC	ADDR 6
A26-B-14	AO-J3-17 ETC	ADDR 5
A26-B-16	AO-J3-15 ETC	ADDR 13
A26-B-18	AO-J2-56 ETC	DATA 3
A26-B-19	AO-J3-9 ETC	DATA 2
A26-B-20	AO-J3-10 ETC	DATA 1
A26-B-21	AO-J3-7 ETC	DATA 0
A26-B-30	GND	

A27 -- SWEEP CLOCK, FREQUENCY HOLD (60-pin connector, A1-A30 & B1-B30)

from:	to:	notes:
A27-A-1	GND	
A27-A-2	-15 SUPPLY	
A27-A-3	+15 SUPPLY	
A27-A-4	-5.2 SUPPLY	
A27-A-6	A25-A-14	BAND END
A27-A-7	AO-J3-8	START/REC-NOT
A27-A-8	A4-J3-1 & A124-1 & FRONT PANEL BNC	SWEEP SYNC TRIG

A27-A-9	A26-A-7 & A25-A-16	UNBLANK
A27-A-10	A25-A-18	CLOCK
A27-A-11	A27-B-8 & AO-J2-53 & A124-25	PEN LIFT EN
A27-A-12	A124-2 & REAR PANEL BNC	PEN LIFT
A27-A-13	AO-J3-6	RESET FMC MEM
A27-A-23	A1-J3-24 & A26-A-23	DNCNV FILTER 1
A27-A-24	A1-J3-22 & A26-A-24	DNCNV FILTER 2
A27-A-25	A25-B-14	SWEEP OUT
A27-A-26	A24-B-25 & A25-B-24	OE/NOT
A27-A-27	A124-15 & FRONT PANEL BNC	10V RAMP OUT
A27-A-29	+5 SUPPLY	
A27-A-30	GND	
A27-B-1	GND	
A27-B-7	A1-J3-21 & A124-11	EXT TRIG EN
A27-B-8	A27-A-11 & AO-J2-53 & A124-25	PEN LIFT EN
A27-B-9	A24-A-5	BAND RESET
A27-B-10	AO-J3-1 ETC	SWEEP RESET
A27-B-11	A6-H & A124-3	READY
A27-B-12	A6-F & A124-12	TO OUTPUT PLL
A27-B-13	A6-21 & A124-4	FROM PLL
A27-B-14	A1-J3-17 & A124-13	C BLANK
A27-B-15	A124-5 & A118-T1	RF OFF
A27-B-30	GND	

A101 -- POWER SUPPLY

from:	to:	notes:
A101-1	HI STAB OSC 1	+15V OPTION 06 ONLY
A101-2	HI STAB OSC 5	GND OPTION 06 ONLY
A101-3	XFMR SECONDARY	YELLOW WIRE OPTION 06
A101-4	XFMR SECONDARY	YELLOW WIRE OPTION 06
A101-5	P.S. CR2 (-)	
A101-6	A102-18	
A101-7	GND	
A101-8	A102-C	
A101-9	XFMR SECONDARY	
A101-10	XFMR SECONDARY	
A101-11	XFMR SECONDARY, GND	

A102 -- COMPUTER BUS

from:	to:	notes:
A102-1	P.S. C3 (+)	+24V
-1 OR -J4-6	ATTEN RED WIRE & A5-J1-1	
A102-2 OR -J4-2	ATTEN YEL WIRE & A5-J1-3	10 ON
A102-3 OR -J4-13	ATTEN VIO WIRE & A5-J1-5	10 OFF
A102-4 OR -J4-11	ATTEN BLK WIRE & A5-J1-7	20 OFF
A102-5 OR -J4-5	ATTEN GRN WIRE & A5-J1-9	20 ON
A102-6 OR -J4-3	ATTEN ORA WIRE & A5-J1-11	40 OFF #1
A102-7 OR -J4-9	ATTEN BLU WIRE & A5-J1-13	40 ON #1

A102-8 OR -J4-4	ATTEN BRN WIRE & A5-J1-15	40 OFF #2
A102-9 OR -J4-10	ATTEN WHT WIRE & A5-J1-17	40 ON #2
A102-A	XFMR SECONDARY	8VAC
A102-B	XFMR SECONDARY	8VAC
A102-C	A101-8	
A102-D	GND	
A102 '+5'	HEATSINK Q1 OUT	+5V
'+5'	XFMR SECONDARY	8VAC
A102 '-5.2'	HEATSINK Q2 OUT	-5.2V
'-5.2'	A5-J2-6	
A102 '-18'	A101-8	-18V
A102 '+18'	HEATSINK Q3 OUT	+18V
A102 J4	SEE A102-1 THRU -9 ABOVE	
****(RIBBON)*****		
A102 P1 PINS 1-26	A103 P1 PINS 1-26 AND	FROM CPU BUS TO RF BUS &
**********	A118 P3 PINS 1-26	MODULATION CONTROL
****(RIBBON)*****		
A102 P2 PINS 1-20	A107 P1 PINS 1-20 AND	FROM CPU BUS TO FREQUENCY
**********	A109 P1 PINS 1-20	& LEVEL SWITCHES
****(RIBBON)*****		
A102 P3 PINS 1-16	A103 P2 PINS 1-16 AND	FROM CPU BUS TO RF BUS &
**********	A118 P2 PINS 1-16	MOD CONTROL
****(RIBBON)*****		
A102 P4 PINS 1-34	A110 P1 PINS 1-34	FROM CPU BUS TO MOD/PWR
**********		DISPLAY
****(RIBBON)*****		
A102 P5 PINS 1-26	A108 P1 PINS 1-26	FROM CPU BUS TO FREQUENCY
**********		DISPLAY
****(RIBBON)*****		
A102 P6 PINS 1-10	A111 P1 PINS 1-10	FROM CPU BUS TO INTERFACE
**********		DEVICE ADDRESS
A102 P6 PINS 11-34	REAR PANEL 'REMOTE'	FROM CPU BUS TO REMOTE
**********	(PIN NUMBERS DIFFER)	INTERFACE CONNECTOR
OTHER CONNECTIONS		
A102 P6-11	A3 J1-12 & REMOTE 24	INTFC GND
A102 P6-12	A3 J1-11 & REMOTE 12	INTFC SHIELD
A102 P6-13	A3 J1-14 & REMOTE 23	INTFC GND
A102 P6-14	A3 J1-13 & REMOTE 11	INTFC ATN
A102 P6-15	A3 J1-16 & REMOTE 22	INTFC GND
A102 P6-16	A3 J1-15 & REMOTE 10	INTFC SRQ

A102 P6-17	A3 J1-18 & REMOTE 21	INTFC GND
A102 P6-18	A3 J1-17 & REMOTE 9	INTFC IFC
A102 P6-19	A3 J1-20 & REMOTE 20	INTFC GND
A102 P6-20	A3 J1-19 & REMOTE 8	INTFC NDAC
A102 P6-21	A3 J1-22 & REMOTE 19	INTFC GND
A102 P6-22	A3 J1-21 & REMOTE 7	INTFC NRFD
A102 P6-23	A3 J1-24 & REMOTE 18	INTFC GND
A102 P6-24	A3 J1-23 & REMOTE 6	INTFC DAV
A102 P6-25	A3 J1-26 & REMOTE 17	INTFC REN
A102 P6-26	A3 J1-25 & REMOTE 5	INTFC EOI
A102 P6-27	A3 J1-28 & REMOTE 16	INTFC D108
A102 P6-28	A3 J1-27 & REMOTE 4	INTFC D104
A102 P6-29	A3 J1-30 & REMOTE 15	INTFC D107
A102 P6-30	A3 J1-29 & REMOTE 3	INTFC D103
A102 P6-31	A3 J1-32 & REMOTE 14	INTFC D106
A102 P6-32	A3 J1-31 & REMOTE 2	INTFC D102
A102 P6-33	A3 J1-34 & REMOTE 13	INTFC D105
A102 P6-34	A3 J1-33 & REMOTE 1	INTFC D101

****(RIBBON)*****		
A102 P7 PINS 1-34	A0-J1 PINS 1-34	FROM CPU BUS
**********	A123-P1 PINS 1-34	TO PUSHBUTTON SWITCHES

****(RIBBON)*****		
A102 P8 PINS 1-26	A124-P1 PINS 1-26	FROM CPU BUS TO SWEEP BUS
**********	A0-J3 PINS 1-26	

A103 -- RF BUS (ALSO SEE A6 THROUGH A13)

from:	to:	notes:
A103 FM OUT	YIG OSC. FM COIL (-)	
****(RIBBON)*****		
A103 P1 PINS 1-26	A102 P1 PINS 1-26 AND	FROM RF BUS TO CPU BUS &
**********	A118 P3 PINS 1-26	MOD CONTROL
OTHER CONNECTIONS		
A103 P1-1	A10-F & A9-H & A4 J3-4	LOCK (1 KHZ RES)
A103 P1-2	A12-6 & A4 J3-2	LOCK (110 PLL)
A103 P1-3	A3 J3-3 & A5 J3-3	DAC D0
A103 P1-4	A8-H & A4 J3-3	LOCK (40-80 PLL)
A103 P1-5	A3 J3-6 & A5 J3-5	DAC D2
A103 P1-6	A3 J3-5 & A5 J3-6	DAC D1
A103 P1-7	A3 J3-8 & A5 J3-7	DAC A0
A103 P1-8	A3 J3-7 & A5 J3-8	DAC D3
A103 P1-9	A3 J3-10	DAC A2
A103 P1-10	A3 J3-9 & A5 J3-9	DAC A1
A103 P1-11	A13-R/14 & A3 J3-12 & A5 J3-11	DAC WR/NOT
A103 P1-12	A7-K & A3 J3-11	DIV A
A103 P1-13	A7-L & A3 J3-14	DIV B
A103 P1-14	A4 J3-6	LOCK (300 PLL)

A103 P1-15	A3 J3-19	SEL/NOT 7
A103 P1-16	A6-20 & A4 J3-19	LOCK (OUTPUT PLL)
A103 P1-17	A13-S & A3 J3-20	SEL NOT/0
A103 P1-18	A5 J2-30	SEL AM
A103 P1-19	A3 J3-21	SEL/NOT 4
A103 P1-20	A6-6	FM ON
A103 P1-21	A3 J3-23	SEL/NOT 5
A103 P1-22	A1 J3-22	FILT SEL 2
A103 P1-23	A3 J3-25	SEL/NOT 6
A103 P1-24	A1 J3-24	SEL/NOT 2
A103 P1-25	A3 J3-26	SEL/NOT 3
A103 P1-26	A1 J3-26	FILT SEL 0

****(RIBBON)*****		
A103 P2 PINS 1-16	A102 P3 PINS 1-16 AND	FROM RF BUS TO CPU BUS.&
**********	A118 P2 PINS 1-16	MOD CONTROL
OTHER CONNECTIONS		
A103 P2-1	+18V	
A103 P2-2	+18V	
A103 P2-3	-5.2V	
A103 P2-4	-5.2V	
A103 P2-5	-18V	
A103 P2-6	-18V	
A103 P2-7	+5V	
A103 P2-8	+5V	
A103 P2-11	A1 J3-18	
A103 P2-12	A1 J3-16	
A103 P2-13	A1 J3-14	
A103 P2-14	A1 J3-10	
A103 P2-15	A3 J3-13	SAMPLER FILTER
A103 P2-16	A4 J3-17 & A102 P5-23	REM LED

A104 -- 300 MHz OSCILLATOR

from:	to:	notes:
A104-1	A13-E & A104-4	+18V
A104-2	A13-C & A104-3	-18V
A104-3	A112 '-18' & A104-2	-18V
A104-4	A112 '+18' & A104-1	+18V
A104-5	A13-4/D	-5.2V
A104-6	A13-2/B	+5V
A104-J1	A11-J2	284-319 MHZ OUT
A104-J2	A11-W	TUNE INPUT
A104-J3	A7-J1	IF OUT
A104-J4	RF INPUT	FROM RF COUPLER

A107 -- 8 POSITION LEVER SWITCH

from:	to:	notes:
****(RIBBON)*****		
A107 P1 PINS 1-20	A102 P2 PINS 1-20 AND	FROM FREQ SWITCHES TO CPU
**********	A109 P1 PINS 1-20	BUS & LEVEL SWITCHES
OTHER CONNECTIONS		
A107 P1-1	+5V	
A107 P1-3	A1 J3-2	TWS D8
A107 P1-4	A1 J3-1	TWS D4
A107 P1-5	A1 J3-4	TWS D2
A107 P1-6	A1 J3-3	TWS D1
A107 P1-7	A1 J3-6	TWS STB D
A107 P1-8	A1 J3-5	TWS STB C
A107 P1-9	A1 J3-8	TWS STB B
A107 P1-10	A1 J3-7	TWS STB A
A107 P1-11	A1 J3-11	SPARE
A107 P1-17	A1 J3-17	SPARE
A107 P1-19	A1 J3-19	SPARE

A108 -- FREQUENCY DISPLAY

from:	to:	notes:
****(RIBBON)*****		
A108 P1 PINS 1-26	A102 P5 PINS 1-26	FROM FREQUENCY DISPLAY TO
**********		CPU BUS
OTHER CONNECTIONS		
A108 P1-3	A1 J1-13	DDF 7
A108 P1-4	A1 J1-7	FSEG f
A108 P1-5	A1 J1-4	FSEG e
A108 P1-6	A1 J1-22	FSEG y
A108 P1-7	A1 J1-6	FSEG d
A108 P1-8	A1 J1-5	DDF 0
A108 P1-9	A1 J1-16	DDF 6
A108 P1-10	A1 J1-3	FSEG h
A108 P1-11	A1 J1-12	DDF 4
A108 P1-12	A1 J1-14	DDF 5
A108 P1-13	A1 J1-8	DDF 2
A108 P1-14	A1 J1-10	DDF 3
A108 P1-15	A1 J1-11	FSEG b
A108 P1-16	A1 J1-9	FSEG c
A108 P1-17	A1 J1-15	FSEG a
A108 P1-18	A1 J1-2	DDF 1
A108 P1-23	A4 J3-17 & A102 P3-16	REM LED
A108 P1-24	A4 J3-22	LOCK LED

A109 -- 5 POSITION LEVER SWITCH

from:	to:	notes:
****(RIBBON)*****		
A109 P1 PINS 1-20	A107 P1 PINS 1-20 AND	FROM LEVEL SWITCHES TO FREQ
**********	A102 P2 PINS 1-20	SWITCHES & CPU BUS
OTHER CONNECTIONS		
A109 P1-1	+5V	
A109 P1-3	A1 J3-2	TWS D8
A109 P1-4	A1 J3-1	TWS D4
A109 P1-5	A1 J3-4	TWS D2
A109 P1-6	A1 J3-3	TWS D1
A109 P1-7	A1 J3-6	TWS STB D
A109 P1-8	A1 J3-5	TWS STB C
A109 P1-9	A1 J3-8	TWS STB B
A109 P1-10	A1 J3-7	TWS STB A
A109 P1-11	A1 J3-11	SPARE
A109 P1-17	A1 J3-17	SPARE
A109 P1-19	A1 J3-19	SPARE

A110 -- MODULATION/POWER DISPLAY

from:	to:	notes:
****(RIBBON)*****		
A110 P1 PINS 1-34	A102 P4 PINS 1-34	FROM MOD/PWR DISPLAY TO
**********		CPU BUS
OTHER CONNECTIONS		
A110 P1-3	A5 J1-27	U8 Q0
A110 P1-4	A1 J1-29	PSEG a
A110 P1-5	A5 J1-29	U8 Q1
A110 P1-6	A1 J1-31	PSEG b
A110 P1-7	A5 J1-31	U8 Q2
A110 P1-8	A1 J1-25	PSEG c
A110 P1-9	A5 J1-33	U8 Q3
A110 P1-10	A1 J1-34	PSEG d
A110 P1-11	A5 J1-24	FM
A110 P1-12	A1 J1-32	PSEG e
A110 P1-14	A1 J1-28	PSEG f
A110 P1-16	A1 J1-26	PSEG y
A110 P1-17	A5 J1-34	U8 DS1
A110 P1-18	A1 J1-24	DDP 0
A110 P1-19	A5 J1-32	U8 DS2
A110 P1-20	A1 J1-30	DDP 1
A110 P1-21	A5 J1-30	U8 DS3
A110 P1-22	A1 J1-21	DDP 2
A110 P1-23	A5 J1-28	U8 DS4
A110 P1-24	A1 J1-33	DDP 3
A110 P1-25	A1 J1-23	PSEG t
A110 P1-26	A1 J1-27	DDP 4
A110 P1-27	A4 J3-15	LEVEL LED
A110 P1-28	A1 J1-20	"+" SIGN

A111 -- ADDRESS SWITCH

from:	to:	notes:
****(RIBBON)*****		
A111 P1 PINS 1-10	A102 P6 PINS 1-10	IEEE-488 INTFC DEVICE ADDR
**********		
OTHER CONNECTIONS		
A111 P1-1	A3-J1-2	GND
A111 P1-2	A3-J1-1	DEVICE ADDRESS BIT A4
A111 P1-3	A3-J1-4	GND
A111 P1-4	A3-J1-3	DEVICE ADDRESS BIT A3
A111 P1-5	A3-J1-6	GND
A111 P1-6	A3-J1-5	DEVICE ADDRESS BIT A2
A111 P1-7	A3-J1-8	GND
A111 P1-8	A3-J1-7	DEVICE ADDRESS BIT A1
A111 P1-9	A3-J1-10	GND
A111 P1-10	A3-J1-9	DEVICE ADDRESS BIT A0

A112 -- TEMPERATURE COMPENSATION

from:	to:	notes:
A112 OUT	A5-J3-24	TEMP COMP OUT
A112 '+18'	A104-4	+18V
A112 '-18'	A104-3	-18V

A113 -- OSCILLATOR/MULTIPLIER

from:	to:	notes:
A113-1	A113-2 & -4	-5.2 SUPPLY
A113-2	A113-1 & -4	-5.2 SUPPLY
A113-3	A13-5	+18 V
A113-4	A13-4/D, A113-1 & -2	-5.2 SUPPLY
A113-J1	A8-J2	DELETE FOR OPTION 03
	OR: A10-J1	OPTION 03 ONLY
A113-J3	A9-Y	220 MHZ OUT
A113-J4	A12-H	110 MHZ OUT
A113-J5	A12-F	TUNE INPUT
A113-J6	A11-J1	330 MHZ OUT

A114 -- TCXO

from:	to:	notes:
A114-1	A12-S	DELETE FOR OPTION 06
A114-2	A12-2/B	+5V, DELETE FOR OPTION 06
A114-3	A12-Z	GND, DELETE FOR OPTION 06
A114-4	A12-X	DELETE FOR OPTION 06

A117 -- EXT ALC POT SW

from:	to:	notes:
A117-1	A7-4/D	-5.2V
A117-2	A5-J2-36	EXT O.S.
A117-3	A5-J2-34	EXT DET
A117-4	'EXT ALC INPUT'	REAR PANEL BNC
A117-5	A5-J2-32	SEL EXT ALC
A117 +5V	A7-2/B	+5V

A118 -- MODULATION CONTROL

from:	to:	notes:
****(RIBBON)*****		
A118 P2 PINS 1-16	A102 P3 PINS 1-16	TO CPU BUS & RF BUS
**********	& A103 P2 PINS 1-16	
OTHER CONNECTIONS		
A118 P2-1	+18V	
A118 P2-2	+18V	
A118 P2-3	-5.2V	
A118 P2-4	-5.2V	
A118 P2-5	-18V	
A118 P2-6	-18V	
A118 P2-7	+5V	
A118 P2-8	+5V	
A118 P2-11	A1 J3-18	
A118 P2-12	A1 J3-16	
A118 P2-13	A1 J3-14	
A118 P2-14	A1 J3-10	
A118 P2-15	A3 J3-13	SAMPLER FILTER
A118 P2-16	A4 J3-17 & A102 P5-23	REM LED
****(RIBBON)*****		
A118 P3 PINS 1-26	A102 P1 PINS 1-26	TO CPU BUS & RF BUS
**********	& A103 P1 PINS 1-26	
OTHER CONNECTIONS		
A118-P3-1	A4-J3-4 & A10-F & A9-H	LOCK (1 KHZ RES)
A118-P3-2	A12-6 & A4-J3-2	LOCK (110 PLL)
A118-P3-3	A3-J3-3 & A5-J3-3	DAC DATA 0
A118-P3-4	A8-H & A4-J3-3	LOCK (40-80 PLL)
A118-P3-5	A3-J3-6 & A5-J3-5	DAC DATA 2
A118-P3-6	A5-J3-5 & A5-J3-6	DAC DATA 1
A118-P3-7	A5-J3-8 & A5-J3-7	DAC ADDR 0
A118-P3-8	A3-J3-7 & A5-J3-8	DAC DATA 3
A118-P3-9	A3-J3-10	DAC ADDR 2
A118-P3-10	A3-J3-9 & A5-J3-9	DAC ADDR 1
A118-P3-11	A3-J3-12 & A13-R/14 & A5-J3-11	DAC WR/NOT
A118-P3-12	A7-K & A3-J3-11	DIV A
A118-P3-13	A7-L & A3-J3-14	DIV B
A118-P3-14	A4-J3-6	LOCK (300 PLL)
A118-P3-15	A3-J3-19	SEL 7/NOT

A118-P3-16	A6-20 & A4-J3-19	LOCK (OUTPUT PLL)
A118-P3-17	A13-S & A3-J3-20	SEL 0/NOT
A118-P3-18	A5-J2-30	SEL AM
A118-P3-19	A3-J3-21	SEL 4/NOT
A118-P3-20	A6-6	FM ON
A118-P3-21	A3-J3-23	SEL 5/NOT
A118-P3-22	A1-J3-22	FILT SEL 2
A118-P3-23	A3-J3-25	SEL 6/NOT
A118-P3-24	A1-J3-24	SEL 2/NOT
A118-P3-25	A3-J3-26	SEL 3/NOT
A118-P3-26	A1-J3-26	FILT SEL 0
A118-T1	A124-5 & A27-B-15	RF OFF

A124 -- SWEEP BUS (ALSO SEE A24 THROUGH A27)

from:	to:	notes:
A124-1	A4-J3-1 & A27-A-8	SWEEP SYNC TRIG
A124-2	PEN LIFT & A27-A-12	REAR PANEL BNC
A124-3	A6-H & A27-B-11	READY
A124-4	A6-21 & A27-B-13	FROM PLL
A124-5	A118-T1 & A27-B-15	RF OFF
A124-6	A1-J3-22 & A26-A-24 & A27-A-24	DNCNV FILTER 2
A124-7	A5-J3-26 & A26-A-27	LEVEL CORR
A124-8	A1-J3-23 & A25-A-12	NARROW SWEEP/NOT
A124-9	A25-A-17 & UNBLANK/MARKER	REAR PANEL BNC
A124-10	A13-K & A0-J3-1 & A24-A-6 & A26-B-6 & A27-B-10	SWEEP RESET
A124-11	A1-J3-21 & A27-B-7	EXT TRIG EN
A124-12	A6-F & A27-B-12	TO PLL
A124-13	A1-J3-17 & A27-B-14	C BLANK
A124-14	A3-J3-13 & A26-A-25	DNCNV FILTER 3
A124-15	SWEEP OUT BNC & A27-A-27	FRONT PANEL RAMP OUTPUT
A124-16	A0-J2-55 & A24-A-22 & A25-B-22 & A26-A-20	DATA 5
A124-17	.5V/GHZ RAMP OUT	REAR PANEL BNC
A124-18	A4-J3-5 & A0-J3-4	BAND RESET
A124-19	A0-J2-52 & A24-A-23 & A25-B-27 & A26-A-18	DATA 7
A124-20	A1-J3-19 & A24-A-24	MARKER READ/NOT
A124-21	A1-J3-26 & A26-A-22	DNCNV FILTER 0
A124-22	A1-J3-24 & A26-A-23 & A27-A-23	DNCNV FILTER 1
A124-23	YIG +15 SUPPLY	
A124-24	A13-H & A25-A-11	YIG RAMP
A124-25	A0-J2-53 & A27-A-11	PEN LIFT EN
A124-26	-15 SUPPLY	
A124-27	A0-J2-54 & A24-B-23 & A25-A-25 & A26-A-19	DATA 6
A124-28	A0-J2-56 & A24-A-21 & A25-A-22 & A26-B-18	DATA 3

A124-29	-5.2 SUPPLY	
A124-30	+5 SUPPLY	
****(RIBBON)*****		
A124 P1 PINS 1-26	A102 P8 PINS 1-26 & A0 J3 PINS 1-26	FROM SWEEP BUS TO CPU BUS
**********		
OTHER CONNECTIONS		
A124 P1-1	A13-K & A24-A-6 & A26-B-6 & A26-B-7 & A27-B-10 & A124-10	SWEEP RESET
A124 P1-3	A24-B-22 & A25-B-21 & A26-A-21	DATA 4
A124 P1-4	A4-J3-5 & A124-18	BAND RESET
A124 P1-5	A24-A-8 & A25-A-27 & A26-A-26	WRITE-NOT/READ
A124 P1-6	A27-A-13	RESET FMC MEM
A124 P1-7	A24-B-20 & A25-A-28 & A26-B-21	DATA 0
A124 P1-8	A27-A-7	START/REC-NOT
A124 P1-9	A24-B-21 & A25-A-23 & A26-B-19	DATA 2
A124 P1-10	A24-A-20 & A25-B-26 & A26-B-20	DATA 1 .
A124 P1-11	A24-B-9 & A26-A-17	ADDR 15
A124 P1-12	A24-A-12 & A26-B-11	ADDR 7
A124 P1-13	A24-B-11 & A26-B-13	ADDR 6
A124 P1-14	A24-A-9 & A26-A-16	ADDR 14
A124 P1-15	A24-B-10 & A26-B-16	ADDR 13
A124 P1-16	A24-A-10 & A26-A-15	ADDR 12
A124 P1-17	A24-B-12 & A26-B-14	ADDR 5
A124 P1-18	A24-B-16 & A26-A-9	ADDR 11
A124 P1-19	A24-A-13 & A26-B-12	ADDR 4
A124 P1-20	A24-B-14 & A26-B-9	ADDR 8
A124 P1-21	A24-A-11 & A26-A-14	ADDR 0
A124 P1-22	A24-A-15 & A26-A-11	ADDR 9
A124 P1-23	A24-B-13 & A26-A-13	ADDR 1
A124 P1-24	A24-A-16 & A26-A-10	ADDR 10
A124 P1-25	A24-A-14 & A26-A-12	ADDR 2
A124 P1-26	A24-B-15 & A26-B-10	ADDR 3

PARTS LISTS

Parts List for M610 / 2-8 SHIPPING ASY No. 309DA00700 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	309DA00800	1	58900	309DA00800	M610 TEST ASY
2	309AA01400	1	58900	309AA01400	M610 ROM SET V
3	309DF00100	1	58900	309DF00100	M610 FRONT PANEL
4	304DA08701	1	58900	304DA08701	BENCHTOP CABINETIZING M61
5	304CA08600	1	58900	304CA08600	M600 FREQ. 2-8 ASY

Parts List for M600 FREQ. 2-8 ASY No. 304CA08600 Rev. B

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	304BF07500	1	58900	304BF07500	OSCILLATOR SHIM/2-8
3	004BA13000	1	58900	004BA13000	2-8 MODULE, 600(M180)
4	MPB0-01803	1	28480	33322H-90	0-110DB 18GHZ PGM ATTEN
5	MOYT-10208	1	24539	Y085-2217	2-8GHZ YIG XSTR OSC
6	JRAA-00200	1	98291	50-673-0159-31	SMA M TO SMA M ADAPT
7	RN55-00150	1	05905	SMA 0207 E 96	15 OHMS 1% MET FILM
8	RC20-00220	1	01121	EB-220-5	22 OHMS 5% 1/2W CARBON
9	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
10	304CA09801	1	58900	304CA09801	.085 CABLE #600A ASY
11	MDS0-00034	1	H0002	D2262-44	.01-34GHZ DETECTOR
12	304CA09903	1	58900	304CA09903	.141 CABLE #600C ASY
13	304CA09802	1	58900	304CA09802	.085 CABLE #600B ASY
14	RW25-00070	1	15915	TM25-7 OHM-1%Y	7 OHM 25W KELVIN LEAD

Parts List for M610 / 6-12 SHIPPING ASY No. 309DA00701 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	309DA00800	1	58900	309DA00800	M610 TEST ASY
2	309AA01400	1	58900	309AA01400	M610 ROM SET V
3	309DF00100	1	58900	309DF00100	M610 FRONT PANEL
4	304DA08701	1	58900	304DA08701	BENCHTOP CABINETIZING M61
5	304CA08603	1	58900	304CA08603	M600 FREQ. 6-12 ASY

Parts List for M600 FREQ. 6-12 ASY No. 304CA08603 Rev. B

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	301CF00400	1	58900	301CF00400	OSCILLATOR BRACKET
2	004BA14000	1	58900	004BA14000	5-12 MODULE, 600(M181)
3	MPB0-01803	1	28480	33322H-90	0-110DB 18GHZ PGM ATTEN
4	M0YT-00513	1	24539	Y085-1266	5.4-12.5 GHz YIG OSC
6	RC20-00220	1	01121	EB-220-5	22 OHMS 5% 1/2W CARBON
8	RN55-00150	1	05905	SMA 0207 E 96	15 OHMS 1% MET FILM
9	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
10	JRAA-00200	2	98291	50-673-0159-31	SMA M TO SMA M ADAPT
11	304CA09802	1	58900	304CA09802	.085 CABLE #600B ASY
12	MDS0-00034	1	H0002	D2262-44	.01-34GHZ DETECTOR
13	304CA09903	1	58900	304CA09903	.141 CABLE #600C ASY
14	RW25-00050	1	15915	TM25-5 OHM-1%Y	5 OHM 25W KELVIN LEAD

Parts List for M610 / 10-18 SHIPPING ASY No. 309DA00702 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	309DA00800	1	58900	309DA00800	M610 TEST ASY
2	309AA01400	1	58900	309AA01400	M610 ROM SET V
3	309DF00100	1	58900	309DF00100	M610 FRONT PANEL
4	304DA08701	1	58900	304DA08701	BENCHTOP CABINETIZING M61
5	304CA08602	1	58900	304CA08602	M600 FREQ. 10-18 ASY

Parts List for M600 FREQ. 10-18 ASY No. 304CA08602 Rev. B

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	301CF00400	1	58900	301CF00400	OSCILLATOR BRACKET
2	304CA09901	1	58900	304CA09901	.141 CABLE #600D ASY
3	004BA15000	1	58900	004BA15000	10-18 MODULE, 600(M182)
4	MPB0-01803	1	28480	33322H-90	0-110DB 18GHZ PGM ATTEN
5	M0YT-10818	1	24539	Y085-2639	8-18 YIG OSC, 100 MW
6	RC20-00220	1	01121	EB-220-5	22 OHMS 5% 1/2W CARBON
7	RN55-00150	1	05905	SMA 0207 E 96	15 OHMS 1% MET FILM
8	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
10	JRAA-00200	1	98291	50-673-0159-31	SMA M TO SMA M ADAPT
11	304CA09903	1	58900	304CA09903	.141 CABLE #600C ASY
12	304CA09902	1	58900	304CA09902	.141 CABLE #600E ASY
13	MDS0-00034	1	H0002	D2262-44	.01-34GHZ DETECTOR
15	RW25-00050	1	15915	TM25-5 OHM-1%Y	5 OHM 25W KELVIN LEAD

Parts List for M610 /.01-8 SHIPPING ASY No. 309DA00703 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	309DA00800	1	58900	309DA00800	M610 TEST ASY
2	309AA01400	1	58900	309AA01400	M610 ROM SET V
3	309DF00100	1	58900	309DF00100	M610 DEC PANEL
4	304DA08701	1	58900	304DA08701	BENCHTOP CAB. M610
5	304CA08604	1	58900	304CA08604	M600 FREQ .01-8 ASY
6	304CA11900	1	58900	304CA11900	M600 DWNCONV CHASSIS ASY
7	101BA09702	1	58900	101BA09702	TCXO PCA

Parts List for M610-117 SHIPPING ASY No. 309DA00704 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	309DA00801	1	58900	309DA00801	M610-117 TEST ASY
2	309AA01400	1	58900	309AA01400	M610 ROM SET V
3	309DF00100	1	58900	309DF00100	M610 DEC PANEL
4	304DA08701	1	58900	304DA08701	BENCHTOP CAB. M610
5	304CA08604	1	58900	304CA08604	M600 FREQ .01-8 ASY
6	304CA11900	1	58900	304CA11900	M600 DWNCONV CHASSIS ASY
7	101BA09702	1	58900	101BA09702	TCXO PCA
8	003CA00301	1	58900	003CA00301	03 1KHz RESOL M60X ASY

Parts List for M600 FREQ .01-8 ASY No. 304CA08604 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	004BA13000	1	58900	004BA13000	2-8 MODULE, 600(M180)
2	MOYT-20208	1	24539	Y087-4198	2-8GHZ YIG XSTR OSC
3	MPBO-01303	1	28480	33322G-90	0-110DB 13GHZ PGM ATTEN
4	MDSO-00034	1	H0002	D2262-44	.01-34GHZ DETECTOR
5	304CA09802	1	58900	304CA09802	.085 CABLE #600B ASY
6	304CA09903	1	58900	304CA09903	.141 CABLE #600C ASY
7	304CA09801	1	58900	304CA09801	.085 CABLE #600A ASY
8	JRAA-00200	1	98291	50-673-0159-31	SMA M TO SMA M ADAPT
9	RN55-00150	1	05905	SMA 0207 E 96	15 OHMS 1% MET FILM
10	RC20-00220	1	01121	EB-220-5	22 OHMS 5% 1/2W CARBON
11	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
14	RW25-00070	1	15915	TM25-7 OHM-1%Y	7 OHM 25W KELVIN LEAD
15	304AW08600	1	58900	304AW08600	M600 FREQ. 2-8 W/L

Parts List for M610 TEST ASY No. 309DA00800 Rev. A

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	309DA00900	1	58900	309DA00900	M610 COMPUTER CHASSIS ASY
	2	101BA39100	1	58900	101BA39100	HI STAB OSC PCA
	3	304BA08400	1	58900	304BA08400	CPU PC SHIELD ASY
	4	304BA04300	4	58900	304BA04300	PC SHIELD CKT SIDE ASY
	5	304BF04301	2	58900	304BF04301	PC BD SHIELD FRONT
	6	304DA02000	1	58900	304DA02000	M600 MICROWAVE DECK ASY
	7	301DF01500	2	58900	301DF01500	SIDE GUSSET
	8	304CA01801	1	58900	304CA01801	M610 REAR PANEL ASY
	9	304CA01701	1	58900	304CA01701	M610 HEATSINK ASY
	10	309DA01100	1	58900	309DA01100	M610 FRONT PANEL ASY
	11	309CA01200	1	58900	309CA01200	M610 SWEEP CHASSIS ASY
A	0	309CA00600	1	58900	309CA00600	KEY BD / LED VIA PCA
A	1	101CA29501	1	58900	101CA29501	FAST DISPLAY PIA PC ASSY
A	2	101CA35701	1	58900	101CA35701	MEMORY (64K) PC ASSY
A	3	101CA06701	1	58900	101CA06701	FAST IEEE PIA PC ASSY
A	4	101CA35801	1	58900	101CA35801	FAST CPU (64K) ASSY
A	5	304CA03500	1	58900	304CA03500	LEVEL CONTROL PCA
A	6	304CA01000	1	58900	304CA01000	OUTPUT PLL PCA
A	7	304CA03100	1	58900	304CA03100	DIVIDER PCA
A	8	304CA03000	1	58900	304CA03000	40-80 MHZ PLL PCA
A	11	304CA02200	1	58900	304CA02200	300 MHz PLL PCA
A	12	304CA05600	1	58900	304CA05600	110 MHz REF PLL PCA
A	13	304CA02401	1	58900	304CA02401	YIG DRIVER PCA
A	24	106CA03901	1	58900	106CA03901	ANALOG SWEEP #1 ASSY
A	25	106CA03902	1	58900	106CA03902	ANALOG SWEEP #2 ASSY
A	26	106CA04100	1	58900	106CA04100	DOWN CONV/LVL CORRN ASSY
A	27	309CA01600	1	58900	309CA01600	SWEEP CLK/FREQ HOLD PCA

Parts List for M610-117 TEST ASY No. 309DA00801 Rev. A

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	309DA00900	1	58900	309DA00900	M610 COMPUTER CHASSIS ASY
	3	304BA08400	1	58900	304BA08400	CPU PC SHIELD ASY
	4	304BF04300	4	58900	304BF04300	PC SHIELD CKT SIDE
	5	304BA04301	2	58900	304BA04301	PC SHIELD COMP. SIDE
	6	304DA02000	1	58900	304DA02000	MICROWAVE DECK ASY
	7	301DF01500	2	58900	301DF01500	SIDE GUSSET
	8	304CA01802	1	58900	304CA01802	M610 REAR PANEL ASY
	9	304CA01701	1	58900	304CA01701	M610 HEATSINK ASY
	10	309DA01100	1	58900	309DA01100	M610 FRONT PANEL ASY
	11	309DA01200	1	58900	309DA01200	M610 SWEEP CHASSIS ASY
	12	304BC03600	1	58900	304BC03600	POWER RIBBON CABLE
	13	304BC03700	1	58900	304BC03700	UWAVE/PULSE RIBBON CABLE
	14	304BC03800	1	58900	304BC03800	MOD/PWR DISP RIBBON CABLE
	15	304BC03900	1	58900	304BC03900	FREQ DISP RIBBON CABLE
	16	304BC04000	1	58900	304BC04000	TWS RIBBON CABLE
A	0	309CA00600	1	58900	309CA00600	KEY BD / LED VIA PCA
A	1	101CA29501	1	58900	101CA29501	FAST DISPLAY PIA PCA
A	2	101CA35702	1	58900	101CA35702	MEMORY (64K) PCA
A	3	101CA06701	1	58900	101CA06701	FAST IEEE PIA PCA
A	4	101CA35801	1	58900	101CA35801	FAST CPU (64K) PCA
A	5	304CA03500	1	58900	304CA03500	LEVEL CONTROL PCA
A	6	304CA01001	1	58900	304CA01001	OUTPUT PLL PCA
A	7	304CA03100	1	58900	304CA03100	DIVIDER PCA
A	8	304CA03000	1	58900	304CA03000	40-80 MHZ PLL PCA
A	11	304CA02200	1	58900	304CA02200	300 MHz PLL PCA
A	12	304CA05600	1	58900	304CA05600	110 MHz REF PLL PCA
A	13	304CA02401	1	58900	304CA02401	YIG DRIVER PCA
A	24	106CA03903	1	58900	106CA03903	M610 ANALOG SWEEP #1 PCA
A	25	106CA03904	1	58900	106CA03904	M610 ANALOG SWEEP #2 PCA
A	26	106CA04101	1	58900	106CA04101	M610 DWNCONV/LVL CORR PCA
A	27	309CA01600	1	58900	309CA01600	SWEEP CLK/FREQ HOLD PCA

Parts List for M610 COMPUTER CHASSIS ASY No. 309DA00900 Rev. B

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	304BA01100	1	58900	304BA01100	POWER SUPPLY PCA
2	304CC00201	1	58900	304CC00201	M600/M610 PWR TRANSFORMER
3	304DF00801	1	58900	304DF00801	COMPUTER CHASSIS
4	304CF00701	1	58900	304CF00701	CARD CAGE FRONT WALL
5	304BA03301	1	58900	304BA03301	COMPUTER BUS 610 PCA
6	101CF03400	1	58900	101CF03400	CARD CAGE REAR WALL
7	CE35-08900	2	65517	EMC922AH35T	>9000 UF >35V ELECT.
8	CE15-09180	2	65517	EMC183AG15T	>18000 UF >15V ELECT.
9	DBMC-00980	2	04713	MDA980-2	MDA980-2 BRIDGE RECT.
10	HGP0-04125	12	07556	58-30-40	4.125" CARD GUIDE
11	HIGR-00437	1	06540	1155A	7/16" GROMMET
12	HIGP-00090	1	95987	WG201	FLEXIBLE GROMMET
13	HLLT-60212	5	79963	505-#6	#6 SOLDER LUG
14	HLST-A1211	11	79963	627-.196	#10 SOLDER LUG
15	304AW01600	1	58900	304AW01600	M60X CHASSIS W/L

Parts List for PC SHIELD CKT SIDE ASY No. 304BA04300 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	304BF04300	1	58900	304BF04300	PC SHIELD CKT SIDE
2	HSTS-40604	4	55566	3049-B-440-A-0	4-40 X 3/8 SWAGE SPACER

Parts List for CPU PC SHIELD ASY No. 304BA08400 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	304BF08400	1	58900	304BF08400	CPU PC SHIELD
2	HSTS-60404	4	06540	3047-B-632-A	6-32 X 1/4 SWAGE SPACER

Parts List for PC SHIELD COMP. SIDE No. 304BA04301 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	304BF04300	1	58900	304BF04300	PC SHIELD CKT SIDE
2	HSTS-40604	4	55566	3049-B-440-A-0	4-40 X 3/8 SWAGE SPACER

Parts List for MICROWAVE DECK ASY No. 304DA02000 Rev. D

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	304DF00900	1	58900	304DF00900	MICROWAVE CHASSIS
2	304CA05700	1	58900	304CA05700	OSCILLATOR/MULT PCA
3	304CA05500	1	58900	304CA05500	300 MHz OSC PCA
4	304DA02900	1	58900	304DA02900	RF BUS PCA
5	304BA04600	1	58900	304BA04600	TEMP COMP PCA
6	RW05-01000	1	54343	SP11-23 100@5%	100 OHM 5W CHASSIS MT
8	QBNP-05881	1	04713	2N5881	2N5881 15A 60V 160W NPN
9	JSS0-30003	1	06776	MD3452-G	TO3 SOCKET
10	HQIS-00030	1	55285	7403-09FR-05	TO3 INSULATOR
11	HQCP-00030	1	13103	8903VB	TO3 STYLE COVER
12	HIGP-00750	1	83330	8978	3/4" GROMMET
13	HSTH-62404	6	55566	2120-632-A	6-32 X 1 1/2 HEX SPACER
14	HLLT-60212	1	79963	505-#6	#6 SOLDER LUG
15	HTM0-00001	3	06383	TA1S8	ANCHOR MOUNT
16	HTM0-00002	1	06383	TM2S8	TIE MOUNT .06

Parts List for M610 REAR PANEL ASY No. 304CA01801 Rev. B

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	301DF01300	1	58900	301DF01300	REAR PANEL
2	101BA04700	1	58900	101BA04700	ADDRESS SWITCH PCA
3	304BA09000	1	58900	304BA09000	EXT ALC POT/SW M600 PCA
4	101CC17300	1	58900	101CC17300	IEEE INTERFACE CABLE
5	JLFF-06250	1	05245	6J4	LINE FILTER/CONNEC
6	JRDF-00001	6	02660	31-221	BNC F PANEL MOUNT
7	BHSO-05000	2	23936	5502	FAN SCREEN
8	BHGO-05000	2	82877	476042	FAN FINGER GUARD
9	FSAC-00200	1	03614	MDL-2	FUSE;2A;125V;3AG
10	HPMO-00375	4	83330	652	3/8" HOLE PLUG
11	HPMO-00625	1	18310	790-3010	5/8" HOLE PLUG
12	HLLT-K1114	5	79963	814	3/8" (BNC) SOLDER LUG
13	JRDS-00001	1	13708	31-017	SHORTING CAP

Parts List for M610 REAR PANEL ASY No. 304CA01802 Rev. B

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	301DF01300	1	58900	301DF01300	REAR PANEL
3	304BA09000	1	58900	304BA09000	EXT ALC POT/SW M600 PCA
4	101CC17300	1	58900	101CC17300	IEEE INTERFACE CABLE
5	JLFF-06250	1	05245	6J4	LINE FILTER/CONNEC
6	JRDF-00001	8	02660	31-221	BNC F PANEL MOUNT
7	BHSO-05000	2	23936	5502	FAN SCREEN
8	BHGO-05000	2	82877	476042	FAN FINGER GUARD
9	FSAC-00200	1	03614	MDL-2	FUSE;2A;125V;3AG
10	HPMO-00375	2	83330	652	3/8" HOLE PLUG
11	HPMO-00625	1	18310	790-3010	5/8" HOLE PLUG
12	HLLT-K1114	5	79963	814	3/8" (BNC) SOLDER LUG
13	JRDS-00001	1	13708	31-017	SHORTING CAP
A 109	101BA04700	1	58900	101BA04700	ADDRESS SWITCH PCA

Parts List for M610 HEATSINK ASY No. 304CA01701 Rev. B

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	301BF01600	2	58900	301BF01600	POWER SUPPLY HEATSINK
2	301CF00800	1	58900	301CF00800	FAN SHROUD
3	301BF00700	2	58900	301BF00700	FAN SHROUD COVER
4	BD00-05024	1	23936	MD24B2	24VDC FAN
5	JSS0-30003	4	06776	MD3452-G	TO3 SOCKET
6	HIGR-00750	1	06540	1131D	3/4" GROMMET
7	HQIS-00030	4	55285	7403-09FR-05	TO3 INSULATOR
8	HLLT-40210	1	79963	505-#4	#4 SOLDER LUG
10	HIGR-00375	4	06540	2170	3/8" GROMMET
11	HSCR-60404	1	06540	9224A140	#6 X 1/4 CLEAR SPACER
12	HQWN-02200	1	04713	B51547F019	TO220 SHOULDER WASHER
13	HQIS-01260	1	55285	7403-09FR-51	TO126 INSULATOR
C 12	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 14	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 15	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C 18	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 19	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 20	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 21	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 22	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 23	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 24	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 25	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C 26	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 27	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
Q 1	URK0-03230	1	04713	LM323K	LM323K 5V 3A TO3 REGULATR
Q 2	URK0-03452	1	27014	LM345K-5.2	LM345K-5.2 3A -5.2V REG
Q 3	URK0-78180	1	04713	MC7818CK	MC7818CK 18V 1A TO3 REG
Q 4	URK0-78180	1	04713	MC7818CK	MC7818CK 18V 1A TO3 REG
Q 5	URC0-07805	1	04713	MC7805CT	MC7805CT 1A 5V REG
Q 6	URC0-07815	1	04713	MC7815CT	MC7815CT 1A 15V REG
Q 7	URC0-07915	1	04713	MC7915CT	MC7915CT 1A -15V REG

Parts List for M610 FRONT PANEL ASY No. 309DA01100 Rev. B

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	308DF00201	1	58900	308DF00201	FRONT SUB-PANEL M605/610
2	304DA02300	1	58900	304DA02300	MOD/PWR DISPLAY PCA
3	304CA02602	1	58900	304CA02602	M610 FREQ. DISPLAY PCA
4	304BA02500	1	58900	304BA02500	5 POS LEVER SWITCH PCA
5	304CA02100	1	58900	304CA02100	8 POS LEVER SWITCH PCA
6	308DA00301	1	58900	308DA00301	MODULATION CONTROL PCA
7	309CA00200	1	58900	309CA00200	M610 PUSH BUTTON SW PCA
8	JRDF-00001	5	02660	31-221	BNC F PANEL MOUNT
10	STPO-00202	1	09353	9201 J2 Z2Q	115VAC DPDT SWITCH
12	KBRC-37125	2	86797	GR-50-2	3/8"D ROUND BLACK KNOB
13	HLLT-K1114	5	79963	814	3/8" (BNC) SOLDER LUG
14	HSDH-40803	2	55566	4505-440-SS-0	4-40 X 3/16M/F HEX SPACER
15	HSCR-41604	4	55566	1136-4-A-0	#4 X 1" CLEAR SPACER
16	HSDH-42503	2	55566	4522-440-SS-0	4-40 X 1 9/16 HEX SPACER
17	HSTH-42003	3	56563	2069-440-SS0	3/16 HEX STANDOFF 1 1/4"L

Parts List for M610 SWEEP CHASSIS ASY No. 309CA01200 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	309CF00400	1	58900	309CF00400	SWEEP PC BD MOUNT (RIGHT)
2	309CF00401	1	58900	309CF00401	SWEEP PC BD MOUNT (LEFT)
3	JPSO-20030	5	M0004	MP-0100-30-DP-1	60 PIN PC EDGE CONN
4	HGPO-02500	10	07556	HS2500-38	2.5" CARD GUIDE
5	HLLT-40210	10	79963	505-#4	#4 SOLDER LUG
6	HSCR-60704	2	06540	11276A7	#6 X 7/16 ALUMINUM

Parts List for M610 ROM SET V No. 309AA01400 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	UMNO-02764	4	66148	HN4827C64-G20	HN4827C64G20 8K X8 EPROM
2	309AT01400	1	58900	309AT01400	M610 ROM SET V

Parts List for BENCHTOP CABINETIZING M61 No. 304DA08701 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	301CF00901	1	58900	301CF00901	BOTTOM SUB COVER
2	301CF00900	1	58900	301CF00900	TOP SUB COVER
3	301CF01000	2	58900	301CF01000	FRONT TRIM
4	301BF01100	2	58900	301BF01100	FRONT TRIM, SIDE
5	301DF01200	2	58900	301DF01200	SIDE TRIM
6	101BF21600	1	58900	101BF21600	PC BOARD PULLER
7	101BF01000	4	58900	101BF01000	HANDLE FLANGE
8	101BF01900	2	58900	101BF01900	FOOT SUPPORT
9	301DF01400	4	08900	301DF01400	CORNER FRAME
10	HH00-62456	2	88245	A1034-30	OVAL BLACK HANDLE
11	HHR0-31456	2	88245	A1013-30	ROUND BLACK HANDLE
12	WMP0-03006	1	16428	17506B	RT ANG IEC POWER CORD
13	HFBI-00012	1	21604	MP-40008-4	12" INSIDE MOUNT BAIL
14	HFFL-63202	2	21604	PP 40012-1	LEFT FRONT FOOT
15	HFFR-63202	2	21604	PP 40012-2	RIGHT FRONT FOOT
16	HNTU-63206	8	78553	MP40366	#6 TINNERMAN NUT
19	301CF01700	1	58900	301CF01700	TOP COVER
20	301CF01800	1	08900	301CF01800	BOTTOM COVER
21	101BA08000	1	58900	101BA08000	COMPUTER EXTENDER ASSY
22	101BA08200	1	58900	101BA08200	FLOATING EXTENDER ASSY
23	JLFL-01503	1	05245	85-1503	2A 120V LABEL

Parts List for COMPUTER EXTENDER ASSY No. 101BA08000 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	101BF08000	1	58900	101BF08000	COMPUTER EXTENDER BD
2	JPPO-20013	1	31781	345-026-524-201	26 PIN PC EDGE CONN
3	JPPO-20017	1	31781	345-034-524-201	34 PIN PC EDGE CONN
4	JPPO-20030	1	31781	345-060-524-202	60 PIN PC EDGE CONN

Parts List for FLOATING EXTENDER ASSY No. 101BA08200 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	101BF08200	1	58900	101BF08200	FLOATING EXTENDER BD
2	JPSO-20022	1	81312	HCB22SO	44 PIN PC EDGE CONN

Parts List for KEY BD / LED VIA PCA No. 309CA00600 Rev. D

	Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	309CF00600	1	58900	309CF00600	KEY BD / LED VIA PCB
	2	ETST-06224	1	88245	1280B	TURRET TERMINAL
C	1	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
C	2	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	3	CC50-00390	1	51642	150-100-C0G-390J	39 PF CERAMIC NPO
C	4	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	5	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	6	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	7	CC50-00390	1	51642	150-100-C0G-390J	39 PF CERAMIC NPO
C	8	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	9	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	10	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	11	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	12	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	13	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
C	14	CC50-04100	1	56289	.2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	15	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	16	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	17	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	18	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
R	1	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	2	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	3	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	4	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	5	RN55-21620	1	05905	SMA 0207 E 96	16.2 K OHMS 1% MET FILM
R	6	RN55-23240	1	05905	SMA 0207 E 96	32.4 K OHMS 1% MET FILM
R	7	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R	12	RN55-24990	1	05905	SMA 0207 E 96	49.9 K OHMS 1% MET FILM
U	1	UGN0-01871	1	02735	CDP 1871 ACE	40 PIN;88 KEYS ENCODER
U	2	UGN0-07218	1	32293	ICM 7218 EIJL	LED DRIVER
U	3	UTN0-01231	1	01295	SN74LS123N	SN74LS123N DUAL ONE SHOT
U	4	UTN0-00321	1	01295	SN74LS32N	SN74LS32N QUAD OR
U	5	UTN0-00170	1	01295	SN7417N	SN7417N HEX BUFFER
U	6	101AC28412	1	58900	101AC28412	ADDRESS ROM A0-1
U	7	UTN0-02441	1	01295	SN74LS244N	SNL4LS244N 8X DRIV/RECV
U	8	UTN0-02451	1	01295	SN74LS245N	SN74LS245N 8X TRANSCEIVER
U	9	UTN0-02441	1	01295	SN74LS244N	SNL4LS244N 8X DRIV/RECV
U	10	UGN1-06522	1	34576	R6522AP	RS6522AP VIA, 2 MHZ
U	11	UGN1-06522	1	34576	R6522AP	RS6522AP VIA, 2 MHZ
U	12	UTN0-01322	1	01295	SN74HC132N	SN74HC132N 4X SCHMIDT NAN
XU	1	JSP0-10040	1	09922	DILB40P-108	40 PIN DIP SOCKET
XU	2	JSP0-10040	1	09922	DILB40P-108	40 PIN DIP SOCKET
XU	6	JSP0-10020	1	09922	DILB20P-108	20 PIN DIP SOCKET
XU	10	JSP0-10040	1	09922	DILB40P-108	40 PIN DIP SOCKET
XU	11	JSP0-10040	1	09922	DILB40P-108	40 PIN DIP SOCKET

Parts List for FAST DISPLAY PIA PC ASSY No. 101CA29501 Rev. A

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	101CF29500	1	58900	101CF29500	DISPLAY PIA BD
	2	ETST-06224	1	88245	1280B	TURRET TERMINAL
C	1	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	2	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	3	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	4	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	5	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	6	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	7	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	8	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
C	9	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
R	1	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	2	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	3	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
U	1	UCN0-00400	1	04713	MC14040BCP	MC14040BCP 12 BIT CTR
U	2	UMN0-01824	1	02735	CDP1824CD	CDP1824CD 32X8 RAM
U	3	UCN0-00280	1	04713	MC14028BCP	MC14028BCP BCD/DECIMAL
U	4	UCN0-00290	1	04713	MC14029BCP	MC14029BCP 4 BIT CTR
U	5	UMN0-01824	1	02735	CDP1824CD	CDP1824CD 32X8 RAM
U	6	UCN0-00280	1	04713	MC14028BCP	MC14028BCP BCD/DECIMAL
U	7	UGN1-06821	1	04713	MC68B21P	MC68B21P PIA, 2 MHZ
U	8	UTN0-02451	1	01295	SN74LS245N	SN74LS245N 8X TRANSCEIVER
U	9	UTN0-00170	1	01295	SN7417N	SN7417N HEX BUFFER
U	10	UTN0-00321	1	01295	SN74LS32N	SN74LS32N QUAD OR
U	11	UTN0-02441	1	01295	SN74LS244N	SNL4LS244N 8X DRIV/RECV
U	12	101BC28409	1	58900	101BC28409	ADDRESS ROM A5-1
U	13	UTN0-02441	1	01295	SN74LS244N	SNL4LS244N 8X DRIV/RECV
U	14	UGN1-06821	1	04713	MC68B21P	MC68B21P PIA, 2 MHZ
U	15	UGN1-06821	1	04713	MC68B21P	MC68B21P PIA, 2 MHZ
X	2	JSP0-10018	1	09922	DILB18P-108	18 PIN DIP SOCKET
X	5	JSP0-10018	1	09922	DILB18P-108	18 PIN DIP SOCKET
X	7	JSP0-10040	1	09922	DILB40P-108	40 PIN DIP SOCKET
X	12	JSP0-10020	1	09922	DILB20P-108	20 PIN DIP SOCKET
X	14	JSP0-10040	1	09922	DILB40P-108	40 PIN DIP SOCKET
X	15	JSP0-10040	1	09922	DILB40P-108	40 PIN DIP SOCKET

Parts List for MEMORY (64K) PCA No. 101CA35702 Rev. B

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	101CF35700	1	58900	101CF35700	MEMORY (64K) PCB
	2	ETST-06224	1	88245	1280B	TURRET TERMINAL
C	1	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
C	2	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	3	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	4	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	5	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	6	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	7	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	8	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	9	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	10	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	11	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	12	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	13	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
R	1	RC05-21000	1	01121	BB-103-5	10K; 5% 1/8W CARBON
U	6	UMN1-00881	1	L0001	GR881	NON-VOLATILE RAM
U	8	UTN0-00101	1	01295	SN74LS10N	SN74LS10 TRIPLE NAND
U	9	UTN0-02441	1	01295	SN74LS244N	SNL4LS244N 8X DRIV/RECV
U	10	UTN0-02441	1	01295	SN74LS244N	SNL4LS244N 8X DRIV/RECV
U	11	UTN0-02451	1	01295	SN74LS245N	SN74LS245N 8X TRANSCEIVER
U	12	UTN0-02401	1	01295	SN74LS240N	SN74LS240 8X DRIV/RECV
U	13	UTN0-00111	1	01295	SN74LS11N	74LS11 TRIPLE 3 IN AND
X	1	JSP0-10028	1	09922	DILB28P-108	28 PIN DIP SOCKET
X	2	JSP0-10028	1	09922	DILB28P-108	28 PIN DIP SOCKET
X	3	JSP0-10028	1	09922	DILB28P-108	28 PIN DIP SOCKET
X	4	JSP0-10028	1	09922	DILB28P-108	28 PIN DIP SOCKET
X	5	JSP0-10028	1	09922	DILB28P-108	28 PIN DIP SOCKET
X	6	JSP0-10028	1	09922	DILB28P-108	28 PIN DIP SOCKET

Parts List for FAST IEEE PIA PC ASSY No. 101CA06701 Rev. A

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	101CF06700	1	58900	101CF06700	IEEE PIA BD
	2	ETST-06224	1	88245	1280B	TURRET TERMINAL
C	1	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
C	2	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	3	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	4	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
C	5	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	6	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	7	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	8	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
R	1	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	2	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	3	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	4	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	5	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	6	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	7	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	8	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	9	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	10	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	11	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	12	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	13	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	14	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	15	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	16	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	17	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	18	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
U	1	UTN0-03651	1	01295	SN74LS365N	SN74LS365 HEX DRIVER
U	2	UGN1-09914	1	52840	WD9914PL00	WD9914PL00 IEEE-488
U	3	UIN0-75162	1	01295	SN75162N	SN75162N IEEE BUFFER
U	4	UIN0-75160	1	01295	SN7516ON	SN7516ON IEEE BUFFER
U	5	UTN0-00170	1	01295	SN7417N	SN7417N HEX BUFFER
U	6	UTN0-02451	1	01295	SN74LS245N	SN74LS245N 8X TRANSCEIVER
U	7	UTN0-02441	1	01295	SN74LS244N	SNL4LS244N 8X DRIV/RECV
U	8	101AC28401	1	58900	101AC28401	ADDRESS ROM A1
U	9	UTN0-02441	1	01295	SN74LS244N	SNL4LS244N 8X DRIV/RECV
U	10	UTN0-00321	1	01295	SN74LS32N	SN74LS32N QUAD OR
U	11	UTN0-00001	1	01295	SN74LS00N	SN74LS00 QUAD NAND
U	12	UTN0-01381	1	01295	SN74LS138N	SN74LS138N 3 TO 8 DEC
U	13	UGN1-06821	1	04713	MC68B21P	MC68B21P PIA, 2 MHZ
W	1	WJIB-05022	1	A0003	923345-05	.5" INSULATED JUMPER
W	2	WJIB-05022	1	A0003	923345-05	.5" INSULATED JUMPER
X	2	JSP0-10040	1	09922	DILB40P-108	40 PIN DIP SOCKET
X	8	JSP0-10020	1	09922	DILB20P-108	20 PIN DIP SOCKET
X	13	JSP0-10040	1	09922	DILB40P-108	40 PIN DIP SOCKET

Parts List for FAST CPU (64K) PCA No. 101CA35801 Rev. B

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	101CF35800	1	58900	101CF35800	CPU (64K) PCB
	2	ETST-06224	1	88245	1280B	TURRET TERMINAL
C	1	CC50-00270	1	52763	EDPT-27-NPO-5%	27 PF CERAMIC NPO
C	2	CC50-00270	1	52763	EDPT-27-NPO-5%	27 PF CERAMIC NPO
C	3	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	4	CT20-06022	1	56289	150D225X9020A2	2.2 UF 20V TANTALUM
C	5	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	6	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
C	7	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	8	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	9	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	10	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
C	11	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	12	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	13	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
Q	1	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
R	1	RN55-14990	1	05905	SMA 0207 E 96	4.99 K OHMS 1% MET FILM
R	11	RN55-21210	1	05905	SMA 0207 E 96	12.1 K OHMS 1% MET FILM
R	12	RN55-24750	1	05905	SMA 0207 E 96	47.5 K OHMS 1% MET FILM
R	13	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	14	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	15	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	16	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	17	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	18	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	19	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	20	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
S	1	SDP0-00801	1	71450	206-8	8 SPST DIP SWITCH
S	2	SPP0-00101	1	09353	TP11-H8AB	SPST PC MT PUSHBUTTON
U	1	UTN0-01230	1	01295	SN74123N	SN74123N DUAL ONE SHOT
U	2	UGN1-06809	1	04713	MC68B09P	MC68B09P MICRO. 2 MHZ
U	3	UTN0-02441	1	01295	SN74LS244N	SNL4LS244N 8X DRIV/RECV
U	4	UTN0-02441	1	01295	SN74LS244N	SNL4LS244N 8X DRIV/RECV
U	5	UTN0-02441	1	01295	SN74LS244N	SNL4LS244N 8X DRIV/RECV
U	6	UTN0-02451	1	01295	SN74LS245N	SN74LS245N 8X TRANSCEIVER
U	7	UTN0-02451	1	01295	SN74LS245N	SN74LS245N 8X TRANSCEIVER
U	9	UTN0-01381	1	01295	SN74LS138N	SN74LS138N 3 TO 8 DEC
U	10	UTN0-02401	1	01295	SN74LS240N	SN74LS240 8X DRIV/RECV
U	11	101AC28410	1	58900	101AC28410	ADDRESS ROM A2-1
U	12	UTN0-00170	1	01295	SN7417N	SN7417N HEX BUFFER
U	13	UTN0-00021	1	01295	SN74LS02N	SN74LS02 QUAD NOR
U	14	UGN1-06522	1	34576	R6522AP	RS6522AP VIA, 2 MHZ
X	2	JSP0-10040	1	09922	DILB40P-108	40 PIN DIP SOCKET
X	8	JSP0-10028	1	09922	DILB28P-108	28 PIN DIP SOCKET
X	11	JSP0-10020	1	09922	DILB20P-108	20 PIN DIP SOCKET
X	14	JSP0-10040	1	09922	DILB40P-108	40 PIN DIP SOCKET
Y	1	Y180-00800	1	63468	ED080	8.00MHZ FUND XTAL

Parts List for LEVEL CONTROL PCA No. 304CA03500 Rev. K

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF03500	1	58900	304CF03500	LEVEL CONTROL PCB
	2	ETST-06224	3	88245	1280B	TURRET TERMINAL
C	1	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	2	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	3	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	5	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	6	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	7	CC50-?????	1	51642	150-100-C0G-???J	SELECTED IN TEST
C	8	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
C	9	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
C	10	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	11	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	12	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	13	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	14	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	15	CT15-R6220	1	56289	196D226X9015KA1	22UF 15V 10% RADIAL LEAD
C	16	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	17	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	18	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	19	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	20	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	21	CC50-00330	1	52763	EDPT-33-NP0-5%	33 PF CERAMIC NP0
C	22	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	23	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	24	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	25	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	26	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	27	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	28	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	29	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	30	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	31	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	32	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	33	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	34	CC50-00330	1	52763	EDPT-33-NP0-5%	33 PF CERAMIC NP0
C	35	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	36	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	37	CC50-00220	1	52763	EDPT-22-NP0-5%	22 PF CERAMIC NP0
C	38	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	40	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	41	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	42	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	43	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	44	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	45	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	46	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	47	CC50-01220	1	51642	150-100-C0G-221	220 PF CERAMIC NP0
C	49	CC50-00027	1	51642	100-100-C0G-279C	2.7PF CERAMIC NP0
C	50	CC50-?????	1	51642	150-100-C0G-???J	SELECTED IN TEST
C	51	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C	52	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U

Parts List for LEVEL CONTROL PCA No. 304CA03500 Rev. K

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
C 53	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C 54	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
CR 1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR 2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR 3	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR 4	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR 7	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
L 1	LAD0-05270	1	72259	WEE-2.7	2.7 UH INDUCTOR
Q 1	QBNS-04275	1	27014	PN4275	PN4275 .1A 15V .6W NPN
Q 3	QBPS-03645	1	27014	PN3645	PN3645 .5A 60V .6W PNP
Q 4	QBNS-03643	1	27014	PN3643	PN3643 .5A 30V .6W NPN
Q 5	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
Q 6	QJNS-04091	1	04713	2N4091	2N4091 300HM N CH JFET
Q 7	QJNS-04091	1	04713	2N4091	2N4091 300HM N CH JFET
Q 8	QJNS-04091	1	04713	2N4091	2N4091 300HM N CH JFET
Q 9	QJNS-04091	1	04713	2N4091	2N4091 300HM N CH JFET
R 1	RN55-15620	1	05905	SMA 0207 E 96	5.62 K OHMS 1% MET FILM
R 2	RN55-15620	1	05905	SMA 0207 E 96	5.62 K OHMS 1% MET FILM
R 3	RN55-15620	1	05905	SMA 0207 E 96	5.62 K OHMS 1% MET FILM
R 4	RN55-15620	1	05905	SMA 0207 E 96	5.62 K OHMS 1% MET FILM
R 5	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 6	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 7	RN55-22000	1	05905	SMA 0207 E 96	20 K OHMS 1% MET FILM
R 8	RN55-17500	1	05905	SMA 0207 E 96	7.5 K OHMS 1% MET FILM
R 10	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 11	RN55-11210	1	05905	SMA 0207 E 96	1.21 K OHMS 1% MET FILM
R 12	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 13	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 14	RN55-01000	1	05905	SMA 0207 E 96	100 OHMS 1% MET FILM
R 15	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 16	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 17	RN55-31500	1	05905	SMA 0207 E 96	150 K OHMS 1% MET FILM
R 18	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 19	RN55-00511	1	05905	SMA 0207 E 96	51.1 OHMS 1% MET FILM
R 20	RN55-11500	1	05905	SMA 0207 E 96	1.5 K OHMS 1% MET FILM
R 21	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 22	RN55-13920	1	05905	SMA 0207 E 96	3.92 K OHMS 1% MET FILM
R 23	RAPD-11000	1	73138	89PR1K	1K POT 15T PC MNT
R 24	RN55-34750	1	05905	SMA 0207 E 96	475 K OHMS 1% MET FILM
R 25	RN55-33010	1	05905	SMA 0207 E 96	301 K OHMS 1% MET FILM
R 26	RAPD-21000	1	73138	89PR10K	10K POT 15T PC MNT
R 27	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 28	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R 29	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R 30	RN55-23920	1	05905	SMA 0207 E 96	39.2 K OHMS 1% MET FILM
R 31	RN55-13920	1	05905	SMA 0207 E 96	3.92 K OHMS 1% MET FILM
R 32	RN55-21240	1	05905	SMA 0207 E 96	12.4 K OHMS 1% MET FILM.
R 33	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R 34	RN55-21240	1	05905	SMA 0207 E 96	12.4 K OHMS 1% MET FILM.
R 35	RN55-21500	1	05905	SMA 0207 E 96	15 K OHMS 1% MET FILM
R 36	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM

Parts List for LEVEL CONTROL PCA No. 304CA03500 Rev. K

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
R 37	RN55-21400	1	05905	SMA 0207 E 96	14 K OHMS 1% MET FILM
R 38	RN55-22000	1	05905	SMA 0207 E 96	20 K OHMS 1% MET FILM
R 39	RN55-33010	1	05905	SMA 0207 E 96	301 K OHMS 1% MET FILM
R 40	RN55-25490	1	05905	SMA 0207 E 96	54.9 K OHMS 1% MET FILM
R 41	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 42	RN55-00511	1	05905	SMA 0207 E 96	51.1 OHMS 1% MET FILM
R 43	RAPD-21000	1	73138	89PR10K	10K POT 15T PC MNT
R 44	RN55-14990	1	05905	SMA 0207 E 96	4.99 K OHMS 1% MET FILM
R 45	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 46	RN55-28250	1	05905	SMA 0207 E 96	82.5 K OHMS 1% MET FILM
R 47	RN55-21690	1	05905	SMA 0207 E 96	16.9 K OHMS 1% MET FILM
R 48	RN55-41000	1	05905	SMA 0207 E 96	1 M OHMS 1% MET FILM
R 49	RAPD-11000	1	73138	89PR1K	1K POT 15T PC MNT
R 50	RN55-24320	1	05905	SMA 0207 E 96	43.2 K OHMS 1% MET FILM
R 51	RN55-11500	1	05905	SMA 0207 E 96	1.5 K OHMS 1% MET FILM
R 52	RAPD-22000	1	73138	89PR20K	20K POT 15T PC MNT
R 53	RN55-24220	1	05905	SMA 0207 E 96	42.2 K OHMS 1% MET FILM
R 54	RN55-14990	1	05905	SMA 0207 E 96	4.99 K OHMS 1% MET FILM
R 55	RN55-25360	1	05905	SMA 0207 E 96	53.6 K OHMS 1% MET FILM
R 56	RN55-23740	1	05905	SMA 0207 E 96	37.4 K OHMS 1% MET FILM
R 57	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 58	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 59	RN55-16190	1	05905	SMA 0207 E 96	6.19 K OHMS 1% MET FILM
R 60	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 61	RAPD-31000	1	73138	89PR100K	100K POT 15T PC MNT
R 62	RN55-24320	1	05905	SMA 0207 E 96	43.2 K OHMS 1% MET FILM
R 63	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 64	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 65	RN55-22000	1	05905	SMA 0207 E 96	20 K OHMS 1% MET FILM
R 66	RN55-22320	1	05905	SMA 0207 E 96	23.2 K OHMS 1% MET FILM
R 67	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 68	RN55-24990	1	05905	SMA 0207 E 96	49.9 K OHMS 1% MET FILM
R 69	RN55-28250	1	05905	SMA 0207 E 96	82.5 K OHMS 1% MET FILM
R 70	WJIB-05022	1	A0003	923345-05	.5" INSULATED JUMPER
R 71	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 72	RN55-24990	1	05905	SMA 0207 E 96	49.9 K OHMS 1% MET FILM
R 73	RN55-21500	1	05905	SMA 0207 E 96	15 K OHMS 1% MET FILM
R 74	RN55-24990	1	05905	SMA 0207 E 96	49.9 K OHMS 1% MET FILM
R 75	RN55-21500	1	05905	SMA 0207 E 96	15 K OHMS 1% MET FILM
R 76	RN55-41000	1	05905	SMA 0207 E 96	1 M OHMS 1% MET FILM
R 77	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 78	RN55-02210	1	05905	SMA 0207 E 96	221 OHMS 1% MET FILM
R 79	RN55-02210	1	05905	SMA 0207 E 96	221 OHMS 1% MET FILM
R 80	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 81	RN55-23160	1	05905	SMA 0207 E 96	31.6 K OHMS 1% MET FILM
R 82	RAPD-21000	1	73138	89PR10K	10K POT 15T PC MNT
R 84	RN55-23160	1	05905	SMA 0207 E 96	31.6 K OHMS 1% MET FILM
R 85	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 86	RN55-14990	1	05905	SMA 0207 E 96	4.99 K OHMS 1% MET FILM
R 87	RN55-41000	1	05905	SMA 0207 E 96	1 M OHMS 1% MET FILM
R 88	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM

Parts List for LEVEL CONTROL PCA No. 304CA03500 Rev. K

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
R 89	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 90	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 91	RN55-41000	1	05905	SMA 0207 E 96	1 M OHMS 1% MET FILM
R 92	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 93	RN55-41000	1	05905	SMA 0207 E 96	1 M OHMS 1% MET FILM
R 94	WJIB-05022	1	A0003	923345-05	.5" INSULATED JUMPER
R 95	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 96	RN55-41000	1	05905	SMA 0207 E 96	1 M OHMS 1% MET FILM
R 97	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 98	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 100	RN55-21690	1	05905	SMA 0207 E 96	16.9 K OHMS 1% MET FILM
R 101	RN55-22490	1	05905	SMA 0207 E 96	24.9 K OHMS 1% MET FILM
R 102	RN55-22490	1	05905	SMA 0207 E 96	24.9 K OHMS 1% MET FILM
R 103	RN55-00100	1	05905	SMA 0207 E 96	10 OHMS 1% MET FILM
R 104	RN55-24990	1	05905	SMA 0207 E 96	49.9 K OHMS 1% MET FILM
U 1	UINO-01413	1	04713	MC1413P	MC1413P X7 DRIVER .5A
U 2	UINO-01413	1	04713	MC1413P	MC1413P X7 DRIVER .5A
U 4	UONO-00318	1	27014	LM318N	LM318 HIGH SPEED OPAMP
U 5	ULNO-05042	1	32293	IH5042CPE	IH5042CPE SPDT SWITCH
U 6	ULNO-00360	1	27014	LM360N	HI SPEED COMPARATOR
U 7	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 8	UCNO-04330	1	04713	MC14433P	MC14433P 3 1/2 DIG A/D
U 9	UANO-00441	1	01295	TL441CN	TL441 DUAL LOG AMP
U 10	UONO-00074	1	01295	TL074CN	TL074CN QUAD FET OP AMP
U 11	ULNO-02901	1	27014	LM2901N	LM2901N QUAD COMPARATOR
U 12	URPO-79150	1	04713	MC79L15CP	MC79L15 .1A -15V REG
U 13	URPO-79150	1	04713	MC79L15CP	MC79L15 .1A -15V REG
U 14	URPO-78150	1	04713	MC78L15CP	MC78L15 .1A 15V REG
U 15	URPO-78150	1	04713	MC78L15CP	MC78L15 .1A 15V REG
U 16	UONO-00027	1	24355	AD OP27GN	OP27GN LOW DRIFT OP AMP
U 17	UONO-00027	1	24355	AD OP27GN	OP27GN LOW DRIFT OP AMP
U 21	UANO-00100	1	13919	LOG 100JP	LOG 100JP LOG AMP
U 22	UONO-00074	1	01295	TL074CN	TL074CN QUAD FET OP AMP
U 23	UONO-00027	1	24355	AD OP27GN	OP27GN LOW DRIFT OP AMP
U 24	UINO-07542	1	24355	AD7542KN	AD7542KN 12 BIT D/A
VR 1	DRAE-00827	1	04713	1N827	IN827 6.2V REF. DIODE
VR 2	DRAE-00827	1	04713	1N827	IN827 6.2V REF. DIODE
VR 3	DRAE-00827	1	04713	1N827	IN827 6.2V REF. DIODE

Parts List for OUTPUT PLL PCA No. 304CA01001 Rev. C

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	304CF01001	1	58900	304CF01001	OUTPUT PLL PCB
2	ETST-06224	1	88245	1280B	TURRET TERMINAL
3	HQH0-00010	1	05820	651-B	IC HEATSINK
C 1	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 2	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 4	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 5	CC50-03470	1	51642	150-100-W5R-473	.047 UF CERAMIC X7R
C 6	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 7	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 8	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 9	CC50-03470	1	51642	150-100-W5R-473	.047 UF CERAMIC X7R
C 10	CC50-03470	1	51642	150-100-W5R-473	.047 UF CERAMIC X7R
C 11	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 12	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 13	CC50-05470	1	51642	500-050-601-475M	4.7UF CERAMIC Z5U
C 15	CC50-05470	1	51642	500-050-601-475M	4.7UF CERAMIC Z5U
C 16	CC50-05470	1	51642	500-050-601-475M	4.7UF CERAMIC Z5U
C 17	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 18	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 19	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 21	CC50-01150	1	51642	150-100-C0G-151J	150 PF CERAMIC NPO
C 23	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 24	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 26	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C 27	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C 28	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 29	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 30	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 31	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
CR 1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR 2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR 3	DSA0-02810	1	28480	5082-2810	5082-2810 SCHOT. DIODE
CR 4	DSA0-02810	1	28480	5082-2810	5082-2810 SCHOT. DIODE
CR 6	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR 7	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
CR 8	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
CR 9	DSA0-02810	1	28480	5082-2810	5082-2810 SCHOT. DIODE
CR 10	DSA0-02810	1	28480	5082-2810	5082-2810 SCHOT. DIODE
CR 11	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR 12	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR 13	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
CR 14	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
DS 1	ILRR-00125	1	58361	MV5077B	RED LED 1/8" DIA
Q 1	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
R 1	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 2	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 3	RN55-14990	1	05905	SMA 0207 E 96	4.99 K OHMS 1% MET FILM
R 4	RN55-23570	1	05905	SMA 0207 E 96	35.7 K OHMS 1% MET FILM
R 5	RN55-14990	1	05905	SMA 0207 E 96	4.99 K OHMS 1% MET FILM
R 6	RN55-23570	1	05905	SMA 0207 E 96	35.7 K OHMS 1% MET FILM
R 7	RN55-23570	1	05905	SMA 0207 E 96	35.7 K OHMS 1% MET FILM

Parts List for OUTPUT PLL PCA No. 304CA01001 Rev. C

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
R 8	RN55-14990	1	05905	SMA 0207 E 96	4.99 K OHMS 1% MET FILM
R 11	RN55-21210	1	05905	SMA 0207 E 96	12.1 K OHMS 1% MET FILM
R 12	RN55-23320	1	05905	SMA 0207 E 96	33.2 K OHMS 1% MET FILM
R 13	RN55-28250	1	05905	SMA 0207 E 96	82.5 K OHMS 1% MET FILM
R 14	WJIB-05022	1	A0003	923345-05	.5" INSULATED JUMPER
R 16	RN55-41000	1	05905	SMA 0207 E 96	1 M OHMS 1% MET FILM
R 17	RN55-28250	1	05905	SMA 0207 E 96	82.5 K OHMS 1% MET FILM
R 18	RN55-28250	1	05905	SMA 0207 E 96	82.5 K OHMS 1% MET FILM
R 19	RN55-18250	1	05905	SMA 0207 E 96	8.25 K OHMS 1% MET FILM
R 20	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 21	RN55-12740	1	05905	SMA 0207 E 96	2.74 K OHMS 1% MET FILM
R 24	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 25	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 26	WJIB-05022	1	A0003	923345-05	.5" INSULATED JUMPER
R 29	RN55-12210	1	05905	SMA 0207 E 96	2.21 K OHMS 1% MET FILM
R 30	RN55-18250	1	05905	SMA 0207 E 96	8.25 K OHMS 1% MET FILM
R 31	RN55-01000	1	05905	SMA 0207 E 96	100 OHMS 1% MET FILM
R 32	RN55-28250	1	05905	SMA 0207 E 96	82.5 K OHMS 1% MET FILM
R 33	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 34	RN55-18250	1	05905	SMA 0207 E 96	8.25 K OHMS 1% MET FILM
R 36	RN55-12210	1	05905	SMA 0207 E 96	2.21 K OHMS 1% MET FILM
R 37	RN55-28250	1	05905	SMA 0207 E 96	82.5 K OHMS 1% MET FILM
R 39	RN55-12210	1	05905	SMA 0207 E 96	2.21 K OHMS 1% MET FILM
R 40	RN55-12210	1	05905	SMA 0207 E 96	2.21 K OHMS 1% MET FILM
R 41	RN55-12210	1	05905	SMA 0207 E 96	2.21 K OHMS 1% MET FILM
R 42	RAPD-25000	1	73138	89PR50K	50K POT 15T PC MNT
R 45	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 46	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 47	RN55-13920	1	05905	SMA 0207 E 96	3.92 K OHMS 1% MET FILM
R 48	RC05-26800	1	01121	BB-683-5	68K; 5% 1/8W CARBON
R 49	RC05-26800	1	01121	BB-683-5	68K; 5% 1/8W CARBON
R 50	RC05-26800	1	01121	BB-683-5	68K; 5% 1/8W CARBON
R 51	RC05-26800	1	01121	BB-683-5	68K; 5% 1/8W CARBON
R 52	RN55-02740	1	05905	SMA 0207 E 96	274 OHMS 1% MET FILM
R 53	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 54	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
RM 1	RM7S-05600	1	71450	750-81-R560	560 OHM X 7 SIP NETWRK
U 1	ULNO-05043	1	32293	IH5043CPA	IH5043CPA DUAL SPDT SW
U 2	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 3	UENO-12040	1	04713	MC12040P	MC12040P PHASE/FREQ DET
U 4	UENO-10216	1	04713	MC10216P	MC10216P TRIPLE RCVR
U 5	UONO-00074	1	01295	TL074CN	TL074CN QUAD FET OP AMP
U 6	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 7	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 9	URPO-79150	1	04713	MC79L15CP	MC79L15 .1A -15V REG
U 10	URPO-78150	1	04713	MC78L15CP	MC78L15 .1A 15V REG
VR 3	DZAD-04734	1	04713	1N4734A	IN4734 6.2V ZENER
VR 4	DZAD-04734	1	04713	1N4734A	IN4734 6.2V ZENER

Parts List for DIVIDER PCA No. 304CA03100 Rev. D

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF03100	1	58900	304CF03100	DIVIDER PCB
	2	HSCS-60304	4	06540	RAF 1532-B-6-A	#6 X 3/16SWAGE CLR SPACER
AR	1	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
AR	2	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
C	1	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	2	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	3	CC50-00330	1	52763	EDPT-33-NP0-5%	33 PF CERAMIC NP0
C	4	CC50-00047	1	51642	100-100-C0G-479J	4.7PF CERAMIC NP0
C	5	CC50-00330	1	52763	EDPT-33-NP0-5%	33 PF CERAMIC NP0
C	6	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	7	CC50-03470	1	51642	150-100-W5R-473	.047 UF CERAMIC X7R
C	8	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	9	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	10	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	11	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	12	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	13	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	14	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	15	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	16	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	17	CC50-00330	1	52763	EDPT-33-NP0-5%	33 PF CERAMIC NP0
C	18	CC50-00330	1	52763	EDPT-33-NP0-5%	33 PF CERAMIC NP0
C	19	CC50-00270	1	52763	EDPT-27-NP0-5%	27 PF CERAMIC NP0
C	20	CC50-00270	1	52763	EDPT-27-NP0-5%	27 PF CERAMIC NP0
C	21	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	22	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
J	1	JRBM-00101	1	98291	51-053-0000	SMB M RTANG PC MOUNT
J	2	JRBM-00101	1	98291	51-053-0000	SMB M RTANG PC MOUNT
L	1	LAD0-05270	1	72259	WEE-2.7	2.7 UH INDUCTOR
L	2	LAD0-04150	1	72259	WEE-.15	.15 UH INDUCTOR
L	3	LAD0-04150	1	72259	WEE-.15	.15 UH INDUCTOR
L	4	LAD0-04150	1	72259	WEE-.15	.15 UH INDUCTOR
Q	1	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q	2	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q	3	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q	4	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
R	1	RN55-03920	1	05905	SMA 0207 E 96	392 OHMS 1% MET FILM
R	2	RN55-01300	1	05905	SMA 0207 E 96	130 OHMS 1% MET FILM
R	3	RN55-16810	1	05905	SMA 0207 E 96	6.81 K OHMS 1% MET FILM
R	4	RN55-13320	1	05905	SMA 0207 E 96	3.32 K OHMS 1% MET FILM
R	5	RN55-15620	1	05905	SMA 0207 E 96	5.62 K OHMS 1% MET FILM
R	6	RN55-15620	1	05905	SMA 0207 E 96	5.62 K OHMS 1% MET FILM
R	7	RN55-13320	1	05905	SMA 0207 E 96	3.32 K OHMS 1% MET FILM
R	8	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	9	RN55-11500	1	05905	SMA 0207 E 96	1.5 K OHMS 1% MET FILM
R	10	RN55-00681	1	05905	SMA 0207 E 96	68.1 OHMS 1% MET FILM
R	11	RN55-02210	1	05905	SMA 0207 E 96	221 OHMS 1% MET FILM
R	12	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	13	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	14	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
RM	1	RM7S-05600	1	71450	750-81-R560	560 OHM X 7 SIP NETWRK

Parts List for DIVIDER PCA No. 304CA03100 Rev. D

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
RM	2	RM7S-05600	1	71450	750-81-R560	560 OHM X 7 SIP NETWRK
U	1	URPO-78120	1	04713	MC78L12CP	MC78L12CP .1A 12V REG
U	2	UENO-10131	1	04713	MC10131P	MC10131P DUAL D F/F
U	3	UENO-10131	1	04713	MC10131P	MC10131P DUAL D F/F
U	4	UENO-10131	1	04713	MC10131P	MC10131P DUAL D F/F
U	5	UENO-10102	1	04713	MC10102P	MC10102P QUAD NOR
U	6	UENO-10131	1	04713	MC10131P	MC10131P DUAL D F/F

Parts List for 40-80 MHZ PLL PCA No. 304CA03000 Rev. I

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF03000	1	58900	304CF03000	40-80 MHZ PLL PCB
	2	ETST-06224	1	88245	1280B	TURRET TERMINAL
	3	HSTS-40304	4	06540	9532B-A-0440	4-40 X 3/16 SWAGE SPACER
	4	HQH0-00010	1	05820	651-B	IC HEATSINK
	5	304CF09100	1	58900	304CF09100	TOP PC SHEILD 1.25 X 2.5
	6	304BF09200	2	58900	304BF09200	PC BD SHIELD COVER
	7	304CF09500	1	58900	304CF09500	BOTTOM PC BD SHIELD 1.25
	8	WJIB-05022	2	A0003	923345-05	.5" INSULATED JUMPER
C	1	CC50-01330	1	51642	150-100-C0G-331J	330 PF CERAMIC NPO
C	2	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	4	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	5	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	7	CT25-R7100	1	90201	TDM107M025L6	100 UF 25V TANTALUM
C	8	CT25-R7100	1	90201	TDM107M025L6	100 UF 25V TANTALUM
C	9	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	10	CC50-01220	1	51642	150-100-C0G-221	220 PF CERAMIC NPO
C	12	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	16	CC50-00750	1	51642	200-100-NP0-750J	75 PF CERAMIC NPO
C	17	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	18	CC50-00750	1	51642	200-100-NP0-750J	75 PF CERAMIC NPO
C	21	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	22	CC50-02470	1	51642	200-100-W5R-472K	.0047 UF CERAMIC X7R
C	23	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	24	CC50-02470	1	51642	200-100-W5R-472K	.0047 UF CERAMIC X7R
C	25	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	26	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	27	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	28	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	29	CC50-03470	1	51642	150-100-W5R-473	.047 UF CERAMIC X7R
C	30	CC50-03470	1	51642	150-100-W5R-473	.047 UF CERAMIC X7R
C	31	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	32	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	33	CC50-03470	1	51642	150-100-W5R-473	.047 UF CERAMIC X7R
C	34	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	35	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	37	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	40	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	41	CC50-00390	1	51642	150-100-C0G-390J	39 PF CERAMIC NPO
C	42	CC50-00560	1	51642	150-100-C0G-560J	56 PF CERAMIC NPO
C	43	CC50-00390	1	51642	150-100-C0G-390J	39 PF CERAMIC NPO
C	44	CC50-00220	1	52763	EDPT-22-NP0-5%	22 PF CERAMIC NPO
C	45	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
CR	1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	3	DVA0-00109	1	26629	KV3901	MV109 6-30 PF DIODE
CR	4	DVA0-00109	1	26629	KV3901	MV109 6-30 PF DIODE
DS	1	ILRR-00125	1	58361	MV5077C	RED LED 1/8" DIA
J	1	JRBM-00000	1	98291	51-045-0000	SMB M BULK MOUNT
J	2	JRBM-00000	1	98291	51-045-0000	SMB M BULK MOUNT
L	3	LAB0-03680	1	99800	1026-12	.068 UH INDUCTOR
L	5	LAB0-04100	1	99800	1325-101	.10 UH INDUCTOR

Parts List for 40-80 MHZ PLL PCA No. 304CA03000 Rev. I

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
L 6	LABO-04100	1	99800	1325-101	.10 UH INDUCTOR
L 7	LABO-03470	1	99800	1026-08	.047 UH INDUCTOR
L 8	LABO-03470	1	99800	1026-08	.047 UH INDUCTOR
Q 1	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
Q 2	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q 3	QBNS-00090	1	04713	BFR90	BFR 90 15 V 5 GHZ FT
Q 4	QBNS-00090	1	04713	BFR90	BFR 90 15 V 5 GHZ FT
R 1	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 2	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 3	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 4	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 5	RN55-18250	1	05905	SMA 0207 E 96	8.25 K OHMS 1% MET FILM
R 6	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 7	RN55-32000	1	05905	SMA 0207 E 96	200 K OHMS 1% MET FILM
R 9	RN55-12210	1	05905	SMA 0207 E 96	2.21 K OHMS 1% MET FILM
R 10	RN55-21690	1	05905	SMA 0207 E 96	16.9 K OHMS 1% MET FILM
R 11	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 12	RN55-21470	1	05905	SMA 0207 E 96	14.7 K OHMS 1% MET FILM
R 13	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 14	RN55-00511	1	05905	SMA 0207 E 96	51.1 OHMS 1% MET FILM
R 15	RC05-21000	1	01121	BB-103-5	10K; 5% 1/8W CARBON
R 16	RC05-11000	1	01121	BB-102-5	1.0K; 5% 1/8W CARBON
R 17	RC05-11500	1	01121	BB-152-5	1.5K; 5% 1/8W CARBON
R 18	RC05-11000	1	01121	BB-102-5	1.0K; 5% 1/8W CARBON
R 19	RC05-11000	1	01121	BB-102-5	1.0K; 5% 1/8W CARBON
R 20	RC05-00510	1	01121	BB510-5	51 OHMS 5% 1/8W CARBON
R 21	RN55-00100	1	05905	SMA 0207 E 96	10 OHMS 1% MET FILM
R 22	RN55-22740	1	05905	SMA 0207 E 96	27.4 K OHMS 1% MET FILM
R 23	RN55-21470	1	05905	SMA 0207 E 96	14.7 K OHMS 1% MET FILM
R 24	RN55-22740	1	05905	SMA 0207 E 96	27.4 K OHMS 1% MET FILM
R 25	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 28	RN55-00681	1	05905	SMA 0207 E 96	68.1 OHMS 1% MET FILM
R 29	RN55-03920	1	05905	SMA 0207 E 96	392 OHMS 1% MET FILM
R 30	RN55-01300	1	05905	SMA 0207 E 96	130 OHMS 1% MET FILM
R 32	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 33	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 34	RC05-13900	1	01121	BB-392-5	3.9K; 5% 1/8W CARBON
R 35	RC05-05600	1	01121	RC05GF561-J	560 OHM 5% 1/8W CARBON
R 36	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 37	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
U 1	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 3	UCNO-51460	1	04713	MC145146P	MC145146P FREQ SYNTH
U 4	MMDC-00001	1	15542	ASK-1	1-600MHZ 600MHZ IF MIX
U 5	UENO-12013	1	04713	MC12013P	MC12013 DIV 10/11 600MHZ
U 6	UENO-10231	1	04713	MC10231P	MC10231P DUAL D F/F
U 7	URPO-78120	1	04713	MC78L12CP	MC78L12CP .1A 12V REG
U 8	URPO-78050	1	04713	MC78L05	MC78L05 .1A 5V REG

Parts List for INTERMEDIATE PLL PCA No. 304CA02700 Rev. G

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF02700	1	58900	304CF02700	INTERMEDIATE PLL PCB
	2	ETST-06224	1	88245	1280B	TURRET TERMINAL
	3	HSTS-40304	4	06540	9532B-A-0440	4-40 X 3/16 SWAGE SPACER
	4	304CF09100	1	58900	304CF09100	TOP PC SHEILD 1.25 X 2.5
	5	304BF09200	2	58900	304BF09200	PC BD SHIELD COVER
	6	HQH0-00010	1	05820	651-B	IC HEATSINK
	7	304CF09500	1	58900	304CF09500	BOTTOM PC BD SHIELD 1.25
	8	HBHS-A2403	1	96906	MIL STD	10-24 X 3/16 SET SCREW
AR	2	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
C	1	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	2	CT25-R7100	1	90201	TDM107M025L6	100 UF 25V TANTALUM
C	3	CT25-R7100	1	90201	TDM107M025L6	100 UF 25V TANTALUM
C	4	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	5	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	6	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	7	CC50-01470	1	51642	150-100-C0G-471	470 PF CERAMIC NPO
C	8	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	9	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	10	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	11	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	12	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	13	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	14	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	15	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	16	CK50-00150	1	96733	SG91BY150JSA	15 PF NPO CHIP
C	18	CK50-00050	1	96733	SG0805BY5R0DSA	5 PF NPO CHIP
C	19	CK50-00150	1	96733	SG91BY150JSA	15 PF NPO CHIP
C	21	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	22	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	23	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	24	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	25	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	27	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	28	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	29	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	30	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	31	CC50-03470	1	51642	150-100-W5R-473	.047 UF CERAMIC X7R
C	33	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	34	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	37	CC50-00180	1	51642	150-100-C0G-180J	18 PF CERAMIC NPO
C	38	CC50-00180	1	51642	150-100-C0G-180J	18 PF CERAMIC NPO
C	39	CC50-01220	1	51642	150-100-C0G-221	220 PF CERAMIC NPO
C	40	CC50-01220	1	51642	150-100-C0G-221	220 PF CERAMIC NPO
C	42	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	43	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	44	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	45	CC50-00220	1	52763	EDPT-22-NP0-5%	22 PF CERAMIC NPO
C	46	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
CR	1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	4	DVA0-00109	1	26629	KV3901	MV109 6-30 PF DIODE

Parts List for INTERMEDIATE PLL PCA No. 304CA02700 Rev. G

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
CR 5	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR 6	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR 7	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
DS 1	ILRR-00125	1	58361	MV5077C	RED LED 1/8" DIA
J 1	JRBM-00000	1	98291	51-045-0000	SMB M BULK MOUNT
L 1	LAD0-06270	1	72259	WEE-27	27 UH INDUCTOR
L 2	LAD0-05270	1	72259	WEE-2.7	2.7 UH INDUCTOR
L 3	LAD0-04680	1	72259	WEE-068	.68 uH INDUCTOR
L 5	LAB0-03470	1	99800	1026-08	.047 UH INDUCTOR
L 6	LAB0-03470	1	99800	1026-08	.047 UH INDUCTOR
L 7	LAD0-04330	1	72259	WEE-.33	.33 UH INDUCTOR
Q 1	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
Q 2	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q 3	QBNS-00090	1	04713	BFR90	BFR 90 15 V 5 GHZ FT
Q 4	QBNS-00090	1	04713	BFR90	BFR 90 15 V 5 GHZ FT
R 1	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 2	RN55-12740	1	05905	SMA 0207 E 96	2.74 K OHMS 1% MET FILM
R 3	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 4	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 5	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 6	RN55-21690	1	05905	SMA 0207 E 96	16.9 K OHMS 1% MET FILM
R 7	RN55-12210	1	05905	SMA 0207 E 96	2.21 K OHMS 1% MET FILM
R 8	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 9	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 10	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 11	RN55-21210	1	05905	SMA 0207 E 96	12.1 K OHMS 1% MET FILM
R 12	RN55-25620	1	05905	SMA 0207 E 96	56.2 K OHMS 1% MET FILM
R 13	RC05-21000	1	01121	BB-103-5	10K; 5% 1/8W CARBON
R 14	RC05-11000	1	01121	BB-102-5	1.0K; 5% 1/8W CARBON
R 15	RC05-11500	1	01121	BB-152-5	1.5K; 5% 1/8W CARBON
R 16	RN55-24750	1	05905	SMA 0207 E 96	47.5 K OHMS 1% MET FILM
R 17	RN55-24750	1	05905	SMA 0207 E 96	47.5 K OHMS 1% MET FILM
R 18	RN55-34990	1	05905	SMA 0207 E 96	499 K OHMS 1% MET FILM
R 19	RN55-34990	1	05905	SMA 0207 E 96	499 K OHMS 1% MET FILM
R 20	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 21	RC05-11000	1	01121	BB-102-5	1.0K; 5% 1/8W CARBON
R 22	RC05-00220	1	01121	BB-220-5	22 OHMS 5% 1/8W CARBON
R 23	RC05-01000	1	01121	BB-101-5	100ohms;5% 1/8W CARBON
R 26	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 27	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 28	RN55-03920	1	05905	SMA 0207 E 96	392 OHMS 1% MET FILM
R 29	RN55-01500	1	05905	SMA 0207 E 96	150 OHMS 1% MET FILM
R 30	RN55-01500	1	05905	SMA 0207 E 96	150 OHMS 1% MET FILM
R 31	RN55-03920	1	05905	SMA 0207 E 96	392 OHMS 1% MET FILM
R 32	RN55-03920	1	05905	SMA 0207 E 96	392 OHMS 1% MET FILM
R 33	RN55-00511	1	05905	SMA 0207 E 96	51.1 OHMS 1% MET FILM
R 34	RC05-00100	1	01121	BB-100-5	10 OHMS 5% 1/8W CARBON
R 35	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 36	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 37	RN55-01300	1	05905	SMA 0207 E 96	130 OHMS 1% MET FILM
R 38	RN55-00511	1	05905	SMA 0207 E 96	51.1 OHMS 1% MET FILM

Parts List for INTERMEDIATE PLL PCA No. 304CA02700 Rev. G

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
R 39	RC05-04700	1	01121	BB-471-5	470ohm; 5% 1/8W CARBON
R 40	RC05-13900	1	01121	BB-392-5	3.9K; 5% 1/8W CARBON
R 42	RN55-12210	1	05905	SMA 0207 E 96	2.21 K OHMS 1% MET FILM
R 43	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 44	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
U 1	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 2	URPO-78120	1	04713	MC78L12CP	MC78L12CP .1A 12V REG
U 3	UENO-12040	1	04713	MC12040P	MC12040P PHASE/FREQ DET
U 4	MMDC-00001	1	15542	ASK-1	1-600MHZ 600MHZ IF MIX
U 5	UENO-10131	1	04713	MC10131P	MC10131P DUAL D F/F
U 6	UENO-10216	1	04713	MC10216P	MC10216P TRIPLE RCVR
U 7	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP

Parts List for HI RESOLUTION PCA No. 304CA03400 Rev. F

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF03400	1	58900	304CF03400	HI RESOLUTION PCB
	2	HSTS-40304	4	06540	9532B-A-0440	4-40 X 3/16 SWAGE SPACER
	3	HQH0-00010	2	05820	651-B	IC HEATSINK
	4	304CF09100	1	58900	304CF09100	TOP PC SHEILD 1.25 X 2.5
	5	304BF09200	2	58900	304BF09200	PC BD SHIELD COVER
	6	304CF09500	1	58900	304CF09500	BOTTOM PC BD SHIELD 1.25
	7	ETST-06224	1	88245	1280B	TURRET TERMINAL
AR	1	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
AR	2	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
C	1	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	2	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	3	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	4	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	5	CC50-00270	1	52763	EDPT-27-NP0-5%	27 PF CERAMIC NP0
C	6	CC50-00270	1	52763	EDPT-27-NP0-5%	27 PF CERAMIC NP0
C	7	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	8	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	10	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	11	CK50-00050	1	96733	SG0805BY5R0DSA	5 PF NP0 CHIP
C	12	CK50-00150	1	96733	SG91BY150JSA	15 PF NP0 CHIP
C	13	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	14	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	15	CC50-03470	1	51642	150-100-W5R-473	.047 UF CERAMIC X7R
C	16	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	17	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	18	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	19	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	20	CT25-R7100	1	90201	TDM107M025L6	100 UF 25V TANTALUM
C	21	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	22	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	24	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	27	CC50-02470	1	51642	200-100-W5R-472K	.0047 UF CERAMIC X7R
C	28	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	29	CC50-02470	1	51642	200-100-W5R-472K	.0047 UF CERAMIC X7R
C	30	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	31	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	32	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	33	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	34	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	35	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	37	CC50-02470	1	51642	200-100-W5R-472K	.0047 UF CERAMIC X7R
C	38	CC50-03470	1	51642	150-100-W5R-473	.047 UF CERAMIC X7R
CR	1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	2	DVA0-00109	1	04713	MV109	MV109 6-30 PF DIODE
CR	3	DVA0-00109	1	04713	MV109	MV109 6-30 PF DIODE
CR	4	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
DS	1	ILRR-00125	1	58361	MV5077B	RED LED 1/8" DIA
J	1	JRBM-00000	1	98291	51-045-0000	SMB M BULK MOUNT
L	1	LAD0-04150	1	72259	WEE-.15	.15 UH INDUCTOR
Q	1	QBNS-00090	1	04713	BFR90	BFR 90 15 V 5 GHZ FT
Q	4	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN

Parts List for HI RESOLUTION PCA No. 304CA03400 Rev. F

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
Q 5	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
R 5	RN55-01000	1	05905	SMA 0207 E 96	100 OHMS 1% MET FILM
R 6	RC05-13900	1	01121	BB-392-5	3.9K; 5% 1/8W CARBON
R 7	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 8	RC05-21000	1	01121	BB-103-5	10K; 5% 1/8W CARBON
R 9	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 10	RN55-15620	1	05905	SMA 0207 E 96	5.62 K OHMS 1% MET FILM
R 11	RN55-00562	1	05905	SMA 0207 E 96	56.2 OHMS 1% MET FILM
R 13	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 15	RN55-00100	1	05905	SMA 0207 E 96	10 OHMS 1% MET FILM
R 17	RN55-00100	1	05905	SMA 0207 E 96	10 OHMS 1% MET FILM
R 23	RN55-03920	1	05905	SMA 0207 E 96	392 OHMS 1% MET FILM
R 24	RN55-01300	1	05905	SMA 0207 E 96	130 OHMS 1% MET FILM
R 25	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 26	RN55-32000	1	05905	SMA 0207 E 96	200 K OHMS 1% MET FILM
R 27	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 28	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 29	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 30	RN55-22740	1	05905	SMA 0207 E 96	27.4 K OHMS 1% MET FILM
R 31	RN55-26040	1	05905	SMA 0207 E 96	60.4 K OHMS 1% MET FILM
R 32	RN55-26040	1	05905	SMA 0207 E 96	60.4 K OHMS 1% MET FILM
R 33	RN55-22740	1	05905	SMA 0207 E 96	27.4 K OHMS 1% MET FILM
R 34	RC05-11000	1	01121	BB-102-5	1.0K; 5% 1/8W CARBON
R 35	RC05-11500	1	01121	BB-152-5	1.5K; 5% 1/8W CARBON
R 36	RN55-12210	1	05905	SMA 0207 E 96	2.21 K OHMS 1% MET FILM
R 37	RN55-21690	1	05905	SMA 0207 E 96	16.9 K OHMS 1% MET FILM
R 38	RN55-13920	1	05905	SMA 0207 E 96	3.92 K OHMS 1% MET FILM
R 39	RN55-03920	1	05905	SMA 0207 E 96	392 OHMS 1% MET FILM
R 40	RC05-00820	1	01121	BB-820-5	82 ohms;5% 1/8W CARBON
R 41	RC05-00560	1	01121	BB-560-5	56 OHMS 5% 1/8W CARBON
R 42	RC05-00560	1	01121	BB-560-5	56 OHMS 5% 1/8W CARBON
R 43	RN55-00511	1	05905	SMA 0207 E 96	51.1 OHMS 1% MET FILM
R 44	RC05-00510	1	01121	BB510-5	51 OHMS 5% 1/8W CARBON
RM 1	RM7S-05600	1	71450	750-81-R560	560 OHM X 7 SIP NETWRK
U 2	UINO-03393	1	04713	MC3393P	MC3393P 40MHZ 15/16 CTR
U 4	MMDC-00001	1	15542	ASK-1	1-600MHZ 600MHZ IF MIX
U 5	UCNO-51460	1	04713	MC145146P	MC145146P FREQ SYNTH
U 7	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 8	URPO-78120	1	04713	MC78L12CP	MC78L12CP .1A 12V REG
U 9	UENO-12011	1	04713	MC12011P	MC12011 DIV BY 8/9 600MHZ
U 10	UENO-10131	1	04713	MC10131P	MC10131P DUAL D F/F
U 11	UENO-10102	1	04713	MC10102P	MC10102P QUAD NOR

Parts List for 300 MHz PLL PCA No. 304CA02200 Rev. I

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF02200	1	58900	304CF02200	300 MHZ PLL PCB
	2	HQH0-00010	5	05820	651-B	IC HEATSINK
	4	304CF09300	1	58900	304CF09300	TOP PC SHIELD 1.5 X 1.5
	5	304BF09400	1	58900	304BF09400	PC BD SHIELD COVER
	6	HSTS-40304	4	06540	9532B-A-0440	4-40 X 3/16 SWAGE SPACER
	7	304CF09600	1	58900	304CF09600	BOTTOM PC BD SHIELD 1.5 X
	8	304BF09700	1	58900	304BF09700	BOTTOM PC BD SHIELD COVER
AR	1	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
AR	2	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
C	1	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	2	CC50-00680	1	51642	150-100-C0G-680J	68 PF CERAMIC NPO
C	3	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	4	CC50-00680	1	51642	150-100-C0G-680J	68 PF CERAMIC NPO
C	7	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	8	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	9	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	10	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	12	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	15	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	16	CC50-02470	1	51642	200-100-W5R-472K	.0047 UF CERAMIC X7R
C	17	CC50-02470	1	51642	200-100-W5R-472K	.0047 UF CERAMIC X7R
C	18	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	19	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	20	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	21	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	22	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	23	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	24	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	25	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	26	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	27	CT25-R7100	1	90201	TDM107M025L6	100 UF 25V TANTALUM
CR	1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	3	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
DS	1	ILRR-00125	1	58361	MV5077C	RED LED 1/8" DIA
J	1	JRBM-00000	1	98291	51-045-0000	SMB M BULK MOUNT
J	2	JRBM-00000	1	98291	51-045-0000	SMB M BULK MOUNT
L	1	LAB0-03820	1	99800	1026-14	.082uH INDUCTOR
L	2	LAD0-05270	1	72259	WEE-2.7	2.7 UH INDUCTOR
R	1	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	2	RC05-03300	1	01121	BB-331-5	330ohms 5% 1/8W CARBON
R	3	RC05-03300	1	01121	BB-331-5	330ohms 5% 1/8W CARBON
R	4	RC05-11000	1	01121	BB-102-5	1.0K; 5% 1/8W CARBON
R	5	RC05-11000	1	01121	BB-102-5	1.0K; 5% 1/8W CARBON
R	6	RC05-00220	1	01121	BB-220-5	22 OHMS 5% 1/8W CARBON
R	7	RC05-06800	1	01121	BB-681-5	680ohm; 5% 1/8W CARBON
R	8	RC05-02200	1	01121	BB-221-5	220ohms;5% 1/8W CARBON
R	9	RC05-21200	1	01121	BB-123-5	12K; 5% 1/8W CARBON
R	10	RC05-25600	1	01121	BB-563-5	56K; 5% 1/8W CARBON
R	12	RC05-32700	1	01121	BB-274-5	270 K 5% 1/8W CARBON
R	13	RC05-11000	1	01121	BB-102-5	1.0K; 5% 1/8W CARBON

Parts List for 300 MHz PLL PCA No. 304CA02200 Rev. I

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
R 14	RC05-03300	1	01121	BB-331-5	330ohms 5% 1/8W CARBON
R 15	RC05-03300	1	01121	BB-331-5	330ohms 5% 1/8W CARBON
R 18	RC05-05600	1	01121	RC05GF561-J	560 OHM 5% 1/8W CARBON
R 19	RC05-16800	1	01121	BB-682-5	6.8K; 5% 1/8W CARBON
R 20	RC05-16800	1	01121	BB-682-5	6.8K; 5% 1/8W CARBON
R 21	RC05-05600	1	01121	RC05GF561-J	560 OHM 5% 1/8W CARBON
R 22	RC05-18200	1	01121	BB-822-5	8.2K; 5% 1/8W CARBON
R 23	RC05-18200	1	01121	BB-822-5	8.2K; 5% 1/8W CARBON
R 24	RC05-04700	1	01121	BB-471-5	470ohm; 5% 1/8W CARBON
R 25	RC05-21000	1	01121	BB-103-5	10K; 5% 1/8W CARBON
R 26	RC05-12200	1	01121	BB-222-5	2.2K; 5% 1/8W CARBON
R 27	RC05-13300	1	01121	BB-332-5	3.3K; 5% 1/8W CARBON
R 28	RC05-00470	1	01121	BB-470-5	47 OHMS 5% 1/8W CARBON
R 29	RC05-21000	1	01121	BB-103-5	10K; 5% 1/8W CARBON
R 30	RC05-00510	1	01121	BB510-5	51 OHMS 5% 1/8W CARBON
R 31	RC05-00510	1	01121	BB510-5	51 OHMS 5% 1/8W CARBON
R 32	RN55-01000	1	05905	SMA 0207 E 96	100 OHMS 1% MET FILM
RM 1	RM7S-05600	1	71450	750-81-R560	560 OHM X 7 SIP NETWRK
RM 2	RM7S-21000	1	71450	750-81-R10K	10K OHM X 7 SIP NETWRK
RM 3	RM7S-05600	1	71450	750-81-R560	560 OHM X 7 SIP NETWRK
U 1	UEN1-10136	1	04713	MC10H136P	MC10H136P 250MHZ DIV 16
U 2	UEN0-10109	1	04713	MC10109P	MC10109P DUAL OR/NOR
U 3	UEN1-10136	1	04713	MC10H136P	MC10H136P 250MHZ DIV 16
U 4	MMDC-00001	1	15542	ASK-1	1-600MHZ 600MHZ IF MIX
U 5	ULN0-02901	1	27014	LM2901N	LM2901N QUAD COMPARATOR
U 6	ULN0-02901	1	27014	LM2901N	LM2901N QUAD COMPARATOR
U 7	UEN1-10131	1	04713	MC10H131P	MC10H131P DUAL D F/F
U 8	UEN0-12040	1	04713	MC12040P	MC12040P PHASE/FREQ DET
U 9	ULN0-00311	1	27014	LM311N	LM311N COMPARATOR
U 10	UTN0-01751	1	01295	SN74LS175N	SN74LS175 QUAD D F/F
U 11	UTN0-01751	1	01295	SN74LS175N	SN74LS175 QUAD D F/F
U 12	UTN0-00021	1	01295	SN74LS02N	SN74LS02 QUAD NOR
U 14	UON0-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 15	UEN0-10138	1	04713	MC10138P	MC10138P BI-QUINARY CTR
U 16	UON0-00027	1	24355	AD OP27GN	OP27GN LOW DRIFT OP AMP
U 17	URP0-78120	1	04713	MC78L12CP	MC78L12CP .1A 12V REG

Parts List for 110 MHz REF PLL PCA No. 304CA05600 Rev. E

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF05600	1	58900	304CF05600	110 MHz REF PLL PCB
	2	ETST-06224	1	88245	1280B	TURRET TERMINAL
	3	HSCS-60304	4	06540	RAF 1532-8-6-A	#6 X 3/16SWAGE CLR SPACER
	4	HQH0-00010	3	05820	651-B	IC HEATSINK
C	1	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	2	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	3	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	4	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	5	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	6	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	7	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	8	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	9	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	10	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	11	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	12	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	13	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	14	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	15	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	16	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	17	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	18	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	19	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	20	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	21	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	22	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	23	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	24	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	25	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
CR	1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	3	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	4	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	5	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	6	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	7	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
DS	1	ILRR-00125	1	58361	MV5077C	RED LED 1/8" DIA
L	1	LAD0-05270	1	72259	WEE-2.7	2.7 UH INDUCTOR
L	2	LAD0-05270	1	72259	WEE-2.7	2.7 UH INDUCTOR
Q	1	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
Q	2	QBPS-03645	1	27014	PN3645	PN3645 .5A 60V .6W PNP
Q	3	QBPS-03645	1	27014	PN3645	PN3645 .5A 60V .6W PNP
Q	4	QBNS-00012	1	04713	MPSA12	MPSA12 20K HFE NPN
Q	5	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
R	1	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	2	RN55-04750	1	05905	SMA 0207 E 96	475 OHMS 1% MET FILM
R	3	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	4	RN55-32740	1	05905	SMA 0207 E 96	274 K OHMS 1% MET FILM
R	5	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	6	RN55-24750	1	05905	SMA 0207 E 96	47.5 K OHMS 1% MET FILM
R	7	RN55-24750	1	05905	SMA 0207 E 96	47.5 K OHMS 1% MET FILM

Parts List for 110 MHz REF PLL PCA No. 304CA05600 Rev. E

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
R 8	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 9	RN55-33010	1	05905	SMA 0207 E 96	301 K OHMS 1% MET FILM
R 10	RN55-25620	1	05905	SMA 0207 E 96	56.2 K OHMS 1% MET FILM
R 11	RN55-21210	1	05905	SMA 0207 E 96	12.1 K OHMS 1% MET FILM
R 12	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 13	RN55-01300	1	05905	SMA 0207 E 96	130 OHMS 1% MET FILM
R 14	RN55-00825	1	05905	SMA 0207 E 96	82.5 OHMS 1% MET FILM
R 15	RN55-32740	1	05905	SMA 0207 E 96	274 K OHMS 1% MET FILM
R 16	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 17	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 18	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 19	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 20	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 21	RN55-22210	1	05905	SMA 0207 E 96	22.1 K OHMS 1% MET FILM
R 22	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 23	RN55-04750	1	05905	SMA 0207 E 96	475 OHMS 1% MET FILM
R 24	RN55-21500	1	05905	SMA 0207 E 96	15 K OHMS 1% MET FILM
R 25	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 26	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 27	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 28	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 29	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 30	RC20-00680	1	01121	EB-680-5	68 OHMS 5% 1/2W CARBON
U 1	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 2	URPO-78150	1	04713	MC78L15CP	MC78L15 .1A 15V REG
U 3	URPO-79120	1	04713	MC79L12CP	MC79L12 .1A -12V REG
U 4	UENO-12040	1	04713	MC12040P	MC12040P PHASE/FREQ DET
U 5	UENO-12013	1	04713	MC12013P	MC12013 DIV 10/11 600MHZ
U 6	UENO-10216	1	04713	MC10216P	MC10216P TRIPLE RCVR
U 7	UENO-10124	1	04713	MC10124P	MC10124P QUAD TTL TO ECL
U 8	UTNO-01322	1	01295	SN74HC132N	SN74HC132N 4X SCHMIDT NAN
U 9	URPO-78050	1	04713	MC78L05	MC78L05 .1A 5V REG

Parts List for YIG DRIVER PCA No. 304CA02401 Rev. E

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF02401	1	58900	304CF02401	YIG DRIVER PCB
	2	ETST-06224	1	88245	1280B	TURRET TERMINAL
	3	WJIB-05022	1	A0003	923345-05	.5" INSULATED JUMPER
C	1	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	3	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	6	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	7	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	9	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	10	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	11	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	12	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	13	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	15	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	16	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	17	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	18	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	19	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	20	CC50-00470	1	52763	EDPT-47-NP0-5%	47 PF CERAMIC NP0
C	21	CC50-00470	1	52763	EDPT-47-NP0-5%	47 PF CERAMIC NP0
C	22	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	23	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	25	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	26	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	27	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	28	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	29	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	30	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	31	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
CR	1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
Q	1	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
R	1	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R	2	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
R	3	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
R	4	RAPD-12000	1	73138	89PR2K	2K POT 15T PC MNT
R	5	RN55-18250	1	05905	SMA 0207 E 96	8.25 K OHMS 1% MET FILM
R	6	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	7	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
R	8	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
R	9	RAPD-12000	1	73138	89PR2K	2K POT 15T PC MNT
R	10	RN55-15620	1	05905	SMA 0207 E 96	5.62 K OHMS 1% MET FILM
R	11	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	12	RN55-01000	1	05905	SMA 0207 E 96	100 OHMS 1% MET FILM
R	13	RN55-14990	1	05905	SMA 0207 E 96	4.99 K OHMS 1% MET FILM
R	15	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	16	RN55-14990	1	05905	SMA 0207 E 96	4.99 K OHMS 1% MET FILM
R	17	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	18	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
R	19	RN55-14990	1	05905	SMA 0207 E 96	4.99 K OHMS 1% MET FILM
R	20	RAPD-15000	1	73138	89PR5K	5K POT 15T PC MNT
R	21	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	22	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM

Parts List for YIG DRIVER PCA No. 304CA02401 Rev. E

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
R 23	RAPD-31000	1	73138	89PR100K	100K POT 15T PC MNT
R 24	RAPD-31000	1	73138	89PR100K	100K POT 15T PC MNT
R 25	RN55-41000	1	05905	SMA 0207 E 96	1 M OHMS 1% MET FILM
R 26	RN55-41000	1	05905	SMA 0207 E 96	1 M OHMS 1% MET FILM
R 27	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 28	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 29	RAPD-21000	1	73138	89PR10K	10K POT 15T PC MNT
R 30	RN55-04750	1	05905	SMA 0207 E 96	475 OHMS 1% MET FILM
R 31	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 32	RN55-00475	1	05905	SMA 0207 E 96	47.5 OHMS 1% MET FILM
U 1	UINO-07542	1	24355	AD7542KN	AD7542KN 12 BIT D/A
U 2	UONO-00027	1	24355	AD OP27GN	OP27GN LOW DRIFT OP AMP
U 3	UONO-00027	1	24355	AD OP27GN	OP27GN LOW DRIFT OP AMP
U 5	URPO-79150	1	04713	MC79L15CP	MC79L15 .1A -15V REG
U 6	URPO-78150	1	04713	MC78L15CP	MC78L15 .1A 15V REG
U 7	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 8	UTNO-00041	1	01295	SN74LS04N	SN74LS04 HEX INVERTER
U 9	ULNO-05053	1	32293	IH5053CJE	IH5053 QUAD ANALOG SWITCH
U 10	ULNO-05053	1	32293	IH5053CJE	IH5053 QUAD ANALOG SWITCH
VR 1	DRAE-00827	1	04713	1N827	IN827 6.2V REF. DIODE

Parts List for M610 ANALOG SWEEP #2 PCA No. 106CA03904 Rev. A

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	106CF03902	1	58900	106CF03902	ANALOG SWEEP #2 PCB
	2	ETST-06224	1	88245	1280B	TURRET TERMINAL
	3	WJIB-05022	1	A0003	923345-05	.5" INSULATED JUMPER
C	1	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	2	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	3	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	4	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	5	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	6	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	7	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	8	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	9	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	10	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	11	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	12	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	13	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	14	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
CR	1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
R	1	RN55-08250	1	05905	SMA 0207 E 96	825 OHMS 1% MET FILM
R	2	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R	3	RN55-24990	1	05905	SMA 0207 E 96	49.9 K OHMS 1% MET FILM
R	4	RN55-23320	1	05905	SMA 0207 E 96	33.2 K OHMS 1% MET FILM
R	5	RN55-24990	1	05905	SMA 0207 E 96	49.9 K OHMS 1% MET FILM
R	6	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
U	1	UTN0-00001	1	01295	SN74LS00N	SN74LS00 QUAD NAND
U	2	UIN0-07542	1	24355	AD7542KN	AD7542KN 12 BIT D/A
U	3	UON0-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U	4	ULN0-05018	1	32293	IH5018CPA	IH5018CPA SPDT SWITCH
U	5	UIN0-07531	1	24355	AD7531KN	12 BIT PARALLEL MULT D/A
U	7	UIN0-07531	1	24355	AD7531KN	12 BIT PARALLEL MULT D/A
U	8	UTN0-40402	1	04713	74HC4040	74HC4040 12 BIT COUNTER
U	9	UTN0-40402	1	04713	74HC4040	74HC4040 12 BIT COUNTER
U	10	UTN0-00422	1	18714	74HCT42E	74HCT42 BCD TO DECIMAL
U	11	UTN0-03652	1	18714	74HCT365E	74HCT365 HEX BUFFER
U	12	UTN0-03652	1	18714	74HCT365E	74HCT365 HEX BUFFER
U	13	UTN0-03652	1	18714	74HCT365E	74HCT365 HEX BUFFER
U	14	UTN0-03652	1	18714	74HCT365E	74HCT365 HEX BUFFER
U	15	UMN0-06264	1	61485	HM6264LP-15	HM6264LP-15 8K X 8 RAM
U	16	UTN0-02452	1	18714	74HCT245E	74HCT245E 8X TRANSCEIVER
U	17	UMN0-06264	1	61485	HM6264LP-15	HM6264LP-15 8K X 8 RAM
U	18	UTN0-02452	1	18714	74HCT245E	74HCT245E 8X TRANSCEIVER
VR	1	DRAF-00939	1	04713	1N939	1N939 9.0V REF. DIODE

Parts List for M610 ANALOG SWEEP #1 PCA No. 106CA03903 Rev. A

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	106CF03901	1	58900	106CF03901	ANALOG SWEEP #1 PCB
	2	ETIT-63250	1	88245	1470F	INSULATED TURRET TERMINAL
C	1	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	2	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	3	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	4	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	5	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	6	CC50-?????	1	51642	150-100-C0G-???J	SELECTED IN TEST
C	7	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	8	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	9	CC50-?????	1	51642	150-100-C0G-???J	SELECTED IN TEST
C	10	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	11	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	12	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	13	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	14	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	15	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	16	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	17	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	18	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	19	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	20	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	21	CC50-00330	1	52763	EDPT-33-NP0-5%	33 PF CERAMIC NPO
C	22	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	23	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	24	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	25	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	26	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	27	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	28	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
CR	1	DSA0-02810	1	28480	5082-2810	5082-2810 SCHOT. DIODE
R	1	RN55-08250	1	05905	SMA 0207 E 96	825 OHMS 1% MET FILM
R	2	RN55-00100	1	05905	SMA 0207 E 96	10 OHMS 1% MET FILM
R	3	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
R	4	RN55-21020	1	05905	SMA 0207 E 96	10.2 K OHMS 1% MET FILM
R	5	RN55-01000	1	05905	SMA 0207 E 96	100 OHMS 1% MET FILM
R	6	RN55-21620	1	05905	SMA 0207 E 96	16.2 K OHMS 1% MET FILM
R	7	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	8	RN55-16810	1	05905	SMA 0207 E 96	6.81 K OHMS 1% MET FILM
R	9	RN55-33348	1	05905	SMA 0207 E 96	348 K OHMS 1% MET FILM
R	10	RN55-22320	1	05905	SMA 0207 E 96	23.2 K OHMS 1% MET FILM
R	11	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R	12	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	13	RN55-01000	1	05905	SMA 0207 E 96	100 OHMS 1% MET FILM
R	14	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	15	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	16	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	17	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	18	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	19	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	20	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM

Parts List for M610 ANALOG SWEEP #1 PCA No. 106CA03903 Rev. A

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
U	1	UTNO-40402	1	04713	74HC4040	74HC4040 12 BIT COUNTER
U	2	UINO-07531	1	24355	AD7531KN	12 BIT PARALLEL MULT D/A
U	3	UOGO-00027	1	24355	AD OP27GH	OP27GH LOW DRIFT OP AMP
U	4	ULNO-05018	1	32293	IH5018CPA	IH5018CPA SPDT SWITCH
U	5	ULNO-05018	1	32293	IH5018CPA	IH5018CPA SPDT SWITCH
U	6	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U	7	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U	8	UTNO-00001	1	01295	SN74LS00N	SN74LS00 QUAD NAND
U	9	UTNO-00001	1	01295	SN74LS00N	SN74LS00 QUAD NAND
U	10	UTNO-00041	1	01295	SN74LS04N	SN74LS04 HEX INVERTER
U	11	UTNO-00742	1	18714	74HCT74E	74HCT74 DUAL D FLIP-FLOP
U	12	ULNO-05042	1	32293	IH5042CPE	IH5042CPE SPDT SWITCH
U	13	UCNO-04536	1	18714	CD4536BE	CD4536 24 STAGE TIMER
U	14	UCNO-01030	1	18714	CD40103B	CD40103B 8 STAGE COUNTER
U	15	UCNO-01030	1	18714	CD40103B	CD40103B 8 STAGE COUNTER
U	16	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U	17	UTNO-03732	1	01295	SN74HCT373N	74HCT373 OCTAL D F/F 3 ST
U	18	UTNO-03732	1	01295	SN74HCT373N	74HCT373 OCTAL D F/F 3 ST
U	19	UTNO-03732	1	01295	SN74HCT373N	74HCT373 OCTAL D F/F 3 ST
U	20	UTNO-00022	1	18714	74HCT02E	74HCT02 QUAD 2 IN NOR

Parts List for M610 DWNCONV/LVL CORR PCA No. 106CA04101 Rev. C

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	106CF04100	1	58900	106CF04100	DOWN CONV/LVL CORRN PCB
	2	ETST-06224	1	88245	1280B	TURRET TERMINAL
	3	ETIO-07555	1	98291	0011038000479	FEED THRU TERMINAL
C	1	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	3	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	4	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	5	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	6	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	7	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	8	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	9	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	10	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	11	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	12	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	13	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	14	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	15	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	16	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	17	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	18	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
R	1	RAPD-11000	1	73138	89PR1K	1K POT 15T PC MNT
R	2	RN55-08250	1	05905	SMA 0207 E 96	825 OHMS 1% MET FILM
R	3	RN55-18250	1	05905	SMA 0207 E 96	8.25 K OHMS 1% MET FILM
R	4	RN55-15620	1	05905	SMA 0207 E 96	5.62 K OHMS 1% MET FILM
R	5	RN55-13160	1	05905	SMA 0207 E 96	3.16 K OHMS 1% MET FILM
R	6	RN55-13160	1	05905	SMA 0207 E 96	3.16 K OHMS 1% MET FILM
R	7	RN55-13160	1	05905	SMA 0207 E 96	3.16 K OHMS 1% MET FILM
U	1	UTN0-00322	1	18714	74CHT32E	74HCT32 QUAD 2 IN OR
U	2	UON0-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U	3	UTN0-00322	1	18714	74CHT32E	74HCT32 QUAD 2 IN OR
U	4	UTN0-00082	1	18714	74HC08E	74HC08E QUAD AND
U	5	UTN0-01322	1	01295	SN74HC132N	SN74HC132N 4X SCHMIDT NAN
U	6	UTN0-40402	1	04713	74HC4040	74HC4040 12 BIT COUNTER
U	7	UTN0-03652	1	18714	74HCT365E	74HCT365 HEX BUFFER
U	8	UTN0-03652	1	18714	74HCT365E	74HCT365 HEX BUFFER
U	9	UTN0-03652	1	18714	74HCT365E	74HCT365 HEX BUFFER
U	10	UTN0-03652	1	18714	74HCT365E	74HCT365 HEX BUFFER
U	11	UIN0-00008	1	24355	AD DAC-08CD	AD DAC-08CD 8 BIT DAC
U	12	UTN0-00422	1	18714	74HCT42E	74HCT42 BCD TO DECIMAL
U	13	UMN0-06264	1	61485	HM6264LP-15	HM6264LP-15 8K X 8 RAM
U	14	UMN0-06264	1	61485	HM6264LP-15	HM6264LP-15 8K X 8 RAM
U	15	UTN0-05412	1	04713	MC74HCT541P	MC74HCT541P OCTAL BUFFER
U	16	UTN0-05412	1	04713	MC74HCT541P	MC74HCT541P OCTAL BUFFER
U	17	UTN0-05412	1	04713	MC74HCT541P	MC74HCT541P OCTAL BUFFER
U	18	UTN0-01322	1	01295	SN74HC132N	SN74HC132N 4X SCHMIDT NAN
VR	1	DRAE-00827	1	04713	1N827	IN827 6.2V REF. DIODE

Parts List for SWEEP CLK/FREQ HOLD PCA No. 309CA01600 Rev. E

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	309CF01600	1	58900	309CF01600	SWEEP CLK/FREQ HOLD PCB
	2	ETST-06224	3	88245	1280B	TURRET TERMINAL
C	1	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	2	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	3	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	4	CC50-03470	1	51642	150-100-W5R-473	.047 UF CERAMIC X7R
C	5	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	6	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	7	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	9	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	10	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	11	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	12	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	13	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	14	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	15	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	16	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	17	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	18	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	19	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	20	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	21	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	22	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NP0
C	23	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	24	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	25	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	26	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	27	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	28	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	29	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	30	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	31	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
CR	2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	3	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	4	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
Q	1	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
Q	2	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
R	1	RN55-25110	1	05905	SMA 0207 E 96	51.1 K OHMS 1% MET FILM
R	2	RN55-32740	1	05905	SMA 0207 E 96	274 K OHMS 1% MET FILM
R	3	RAPD-15000	1	73138	89PR5K	5K POT 15T PC MNT
R	4	RN55-13160	1	05905	SMA 0207 E 96	3.16 K OHMS 1% MET FILM
R	5	RN55-13160	1	05905	SMA 0207 E 96	3.16 K OHMS 1% MET FILM
R	6	RN55-18250	1	05905	SMA 0207 E 96	8.25 K OHMS 1% MET FILM
R	7	RN55-13160	1	05905	SMA 0207 E 96	3.16 K OHMS 1% MET FILM
R	8	RN55-14990	1	05905	SMA 0207 E 96	4.99 K OHMS 1% MET FILM
R	9	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	10	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	11	RN55-13160	1	05905	SMA 0207 E 96	3.16 K OHMS 1% MET FILM
R	12	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	13	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	14	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM

Parts List for SWEEP CLK/FREQ HOLD PCA No. 309CA01600 Rev. E

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
R 15	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 16	RN55-32000	1	05905	SMA 0207 E 96	200 K OHMS 1% MET FILM
R 17	RN55-12210	1	05905	SMA 0207 E 96	2.21 K OHMS 1% MET FILM
R 18	RN55-22000	1	05905	SMA 0207 E 96	20 K OHMS 1% MET FILM
R 19	RN55-22000	1	05905	SMA 0207 E 96	20 K OHMS 1% MET FILM
R 20	RN55-12490	1	05905	SMA 0207 E 96	2.49 K OHMS 1% MET FILM
U 1	UTN0-00101	1	01295	SN74LS10N	SN74LS10 TRIPLE NAND
U 2	UTN0-00041	1	01295	SN74LS04N	SN74LS04 HEX INVERTER
U 3	UTN0-01231	1	01295	SN74LS123N	SN74LS123N DUAL ONE SHOT
U 4	UTN0-01322	1	01295	SN74HC132N	SN74HC132N 4X SCHMIDT NAN
U 5	UIN0-00010	1	50721	DAC-IC10BC	DAC-IC10BC 10 BIT D/A
U 6	UTN0-40402	1	04713	74HC4040	74HC4040 12 BIT COUNTER
U 7	UTN0-00741	1	01295	SN74LS74N	SN74LS74 DUAL D F/F
U 8	UTN0-01322	1	01295	SN74HC132N	SN74HC132N 4X SCHMIDT NAN
U 9	ULN0-00311	1	27014	LM311N	LM311N COMPARATOR
U 10	UON0-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 11	UTN0-01231	1	01295	SN74LS123N	SN74LS123N DUAL ONE SHOT
U 12	UIN0-00585	1	24355	AD585AQ	HOLD AMP
U 13	UTN0-01231	1	01295	SN74LS123N	SN74LS123N DUAL ONE SHOT
U 13	UTN0-01231	1	01295	SN74LS123N	SN74LS123N DUAL ONE SHOT
VR 1	DRAE-00827	1	04713	1N827	IN827 6.2V REF. DIODE

Parts List for TCXO PCA No. 101BA09702 Rev. B

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	101BF09702	1	58900	101BF09702	TCXO PCB
C	1	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	2	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	3	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
IC	1	URP0-78120	1	04713	MC78L12CP	MC78L12CP .1A 12V REG
R	1	RN55-01000	1	05905	SMA 0207 E 96	100 OHMS 1% MET FILM
U	1	UTN0-01322	1	01295	SN74HC132N	SN74HC132N 4X SCHMIDT NAN
X	1	101BC18300	1	58900	101BC18300	10 MHZ TCXO SPECIFICATION

Parts List for POWER SUPPLY PCA No. 304BA01100 Rev. D

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304BF01100	1	58900	304BF01100	POWER SUPPLY PCB
	2	ETSB-06224	11	88245	1309B	BIFURCATED TERMINAL 15/64
	3	HQH0-02200	2	13103	6106B-16	TO220 HEATSINK
	4	201BF01200	1	58900	201BF01200	CAPACITOR RETAINER
	5	HSTH-42103	1	56563	2070-440-SS0	5/16 HEX STANDOFF 1 5/16L
	6	HSTS-40704	4	55566	3050-B-440-A	4-40 X 7/16 SWAGE SPACER
	7	ETSB-06216	6	88245	2000B	BIFURCATED TERMINAL 5/32
C	1	CE35-08220	1	56289	503D228F035TJ	>2200UF >35V ELECT.
C	2	CE35-08220	1	56289	503D228F035TJ	>2200UF >35V ELECT.
C	3	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	4	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	5	CE63-07220	1	56289	501D227F063PR	220 UF 63V ELECT.
C	6	CE35-08220	1	56289	503D228F035TJ	>2200UF >35V ELECT.
C	7	CE35-08220	1	56289	503D228F035TJ	>2200UF >35V ELECT.
C	8	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	9	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
CR	1	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
CR	2	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
CR	3	DBMC-00001	1	26923	CSB1	1 A DIP BRIDGE
Q	1	QBNS-00042	1	04713	MPSA42	MPSA42 300V NPN
Q	2	QBNS-00042	1	04713	MPSA42	MPSA42 300V NPN
R	1	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R	2	RN55-00121	1	05905	SMA 0207 E 96	12.1 OHMS 1% MET FILM
R	3	RW03-00030	1	91637	RS-2B-3-1	3ohm 2W WIREWOUND
U	1	URC0-07918	1	04713	MC7918CT	MC7918CT -18V 1A TO220 RE
U	2	URC0-07815	1	04713	MC7815CT	MC7815CT 1A 15V REG
VR	1	DZAD-04753	1	04713	1N4753	IN4753 36 V ZENER

Parts List for COMPUTER BUS 610 PCA No. 304BA03301 Rev. C

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	304CF03301	1	58900	304CF03301	COMPUTER BUS 610 PCB
2	ETSB-06216	16	88245	2000B	BIFURCATED TERMINAL 5/32
3	JPPO-20030	6	31781	345-060-524-202	60 PIN PC EDGE CONN
4	JPPO-20013	5	31781	345-026-524-201	26 PIN PC EDGE CONN
5	JPPO-20017	4	31781	345-034-524-201	34 PIN PC EDGE CONN
6	JIA1-34730	3	52072	CAD34SP100230730	34 PIN STRIPLINE PLUG
7	JIA1-26730	3	52072	CAD26SP100230730	26 PIN STRIPLINE PLUG
8	JIA1-20430	1	52072	CAD20SP100230430	20 PIN STRIPLINE PLUG
9	JIA1-16630	1	52072	CAD16SP100430630	16 PIN STRIPLINE PLUG
10	JSPO-10014	1	09922	DILB14P-108	14 PIN DIP SOCKET

Parts List for RF BUS PCA No. 304DA02900 Rev. E

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF02900	1	58900	304CF02900	RF BUS PCB
	2	JPPG-20022	8	31781	322-044-520-258	44 PIN PC GUIDE CONN
	4	ETSB-06224	7	88245	1309B	BIFURCATED TERMINAL 15/64
	5	HBPP-44005	2	96906	MIL STD	4-40 X 5/16 PAN
	6	HNKS-44004	2	96906	MS35649-***	4-40 KEP NUT
	7	105BF12100	2	58900	105BF12100	FM DRIVER HEATSINK
	8	HQIS-01260	2	55285	XXX	TO126 INSULATOR
C	1	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	2	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	3	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C	4	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C	5	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C	6	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C	7	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C	8	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
CR	1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	3	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	4	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	11	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
CR	12	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
L	1	LAD0-05470	1	72259	WEE-4.7	4.7 UH INDUCTOR
P	1	JIA1-26730	1	52072	CAD26SP100230730	26 PIN STRIPLINE PLUG
P	2	JIA1-16630	1	52072	CAD16SP100430630	16 PIN STRIPLINE PLUG
Q	1	QBNP-06553	1	04713	2N6552	2N6552 1A 88V 10W NPN
Q	2	QBPP-06555	1	04713	MOTO 2N6555	2N6555 1A 60V 10W PNP
Q	3	QBPS-03645	1	27014	PN3645	PN3645 .5A 60V .6W PNP
Q	4	QBNS-03643	1	27014	PN3643	PN3643 .5A 30V .6W NPN
R	1	RC07-00051	1	01121	RC07GF5R1J	5.1 OHMS 5% 1/4W CARBON
R	2	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	3	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	4	RC07-00051	1	01121	RC07GF5R1J	5.1 OHMS 5% 1/4W CARBON
R	5	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	6	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	7	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
U	1	UCN0-00010	1	04713	MC14001BCP	MC14001 QUAD NOR

Parts List for 300 MHz OSC PCA No. 304CA05500 Rev. H

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF05500	1	58900	304CF05500	300 MHz OSC PCB
	2	004BA00000	1	58900	004BA00000	SAMPLER ASSEMBLY
	3	304BF05000	1	58900	304BF05000	END PLATE
	4	304BF05100	1	58900	304BF05100	COMPONENT SIDE WALL S
	5	304BF05200	1	58900	304BF05200	CIRCUIT SIDE SUPPORT S
	6	304BF07200	1	58900	304BF07200	BASE PLATE
	7	304BF07300	2	58900	304BF07300	SIDE PLATE
	8	304BF07400	2	58900	304BF07400	CIRCUIT SIDE STRIP
	9	304CF02800	1	58900	304CF02800	ATTENUATOR MOUNT
	13	304BF04200	1	58900	304BF04200	CONNECTOR MTG. PLATE
	14	304BF08800	1	58900	304BF08800	COMPONENT SIDE WALL L
	15	304BF08900	1	58900	304BF08900	CIRCUIT SIDE SUPPORT L
	17	JRBM-00000	3	98291	51-045-0000	SMB M BULK MOUNT
	18	LFT0-83216	6	89110	859617-1	FEED-THRU FILTER 15A
AR	1	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
AR	2	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
AR	3	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
AR	4	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
AR	5	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
AR	6	MA23-00006	1	24539	MSA-0835	0-6GHZ AMP 23DB 12.5DBM
AR	7	MA23-00006	1	24539	MSA-0835	0-6GHZ AMP 23DB 12.5DBM
C	5	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	6	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	8	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	10	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	11	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	12	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	13	CK50-00050	1	96733	SG0805BY5R0DSA	5 PF NPO CHIP
C	14	CK50-00220	1	96733	SB93BY220JSA	22 PF NPO CHIP
C	15	CK50-00100	1	96733	SG91BY100JSA	10 PF NPO CHIP
C	16	CK50-00050	1	96733	SG0805BY5R0DSA	5 PF NPO CHIP
C	17	CT10-R7220	1	56289	199D227X9010FE2	220UF 10V 10% RADIAL LEAD
C	18	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	19	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	20	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	21	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	22	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	23	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	24	CT20-07100	1	56289	150D107X0020S2	100 UF 20V TANTALUM
C	25	CC50-01220	1	51642	150-100-C0G-221	220 PF CERAMIC NPO
C	26	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	27	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	31	CC50-01220	1	51642	150-100-C0G-221	220 PF CERAMIC NPO
C	32	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	33	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	34	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	35	CC50-00270	1	52763	EDPT-27-NP0-5%	27 PF CERAMIC NPO
C	36	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	37	CC50-00270	1	52763	EDPT-27-NP0-5%	27 PF CERAMIC NPO
C	38	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	39	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R

Parts List for 300 MHz OSC PCA No. 304CA05500 Rev. H

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
C 40	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 41	CC50-00270	1	52763	EDPT-27-NPO-5%	27 PF CERAMIC NPO
C 42	CC50-00270	1	52763	EDPT-27-NPO-5%	27 PF CERAMIC NPO
C 43	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C 44	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 45	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C 46	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C 47	CC50-00270	1	52763	EDPT-27-NPO-5%	27 PF CERAMIC NPO
C 48	CC50-02470	1	51642	200-100-W5R-472K	.0047 UF CERAMIC X7R
C 49	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C 50	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C 51	CC50-00270	1	52763	EDPT-27-NPO-5%	27 PF CERAMIC NPO
C 52	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C 53	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C 54	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C 55	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 56	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C 57	CK50-00050	1	96733	SG0805BY5R0DSA	5 PF NPO CHIP
C 58	CC50-00560	1	51642	150-100-C0G-560J	56 PF CERAMIC NPO
C 59	CT20-07100	1	56289	150D107X0020S2	100 UF 20V TANTALUM
CR 1	DVA0-00109	1	26629	KV3901	MV109 6-30 PF DIODE
CR 2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR 3	DAA0-03401	1	04713	MPN3401	MPN3401 PIN DIODE
CR 4	DSA0-02810	1	28480	5082-2810	5082-2810 SCHOT. DIODE
CR 5	DSA0-02810	1	28480	5082-2810	5082-2810 SCHOT. DIODE
L 1	LR00-00000	1	58900		HAND WOUND COIL
L 2	LR00-00000	1	58900		HAND WOUND COIL
L 3	LAD0-07470	1	72259	WEE-470	470 UH INDUCTOR
L 4	LAD0-06270	1	72259	WEE-27	27 UH INDUCTOR
L 5	LAD0-06270	1	72259	WEE-27	27 UH INDUCTOR
L 6	LAD0-04150	1	72259	WEE-.15	.15 UH INDUCTOR
L 7	LAD0-05270	1	72259	WEE-2.7	2.7 UH INDUCTOR
L 8	LAD0-04150	1	72259	WEE-.15	.15 UH INDUCTOR
L 9	LAD0-05270	1	72259	WEE-2.7	2.7 UH INDUCTOR
L 10	LAD0-05270	1	72259	WEE-2.7	2.7 UH INDUCTOR
L 11	LAD0-04150	1	72259	WEE-.15	.15 UH INDUCTOR
Q 3	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q 4	QBNS-00090	1	04713	BFR90	BFR 90 15 V 5 GHZ FT
R 1	RN55-02210	1	05905	SMA 0207 E 96	221 OHMS 1% MET FILM
R 3	RN55-00100	1	05905	SMA 0207 E 96	10 OHMS 1% MET FILM
R 7	RN55-02430	1	05905	SMA 0207 E 96	243 OHMS 1% MET FILM
R 8	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 9	RN55-04750	1	05905	SMA 0207 E 96	475 OHMS 1% MET FILM
R 11	RN55-00562	1	05905	SMA 0207 E 96	56.2 OHMS 1% MET FILM
R 12	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 13	RN55-00825	1	05905	SMA 0207 E 96	82.5 OHMS 1% MET FILM
R 14	RN55-12430	1	05905	SMA 0207 E 96	2.43 K OHMS 1% MET FILM
R 15	RN55-16190	1	05905	SMA 0207 E 96	6.19 K OHMS 1% MET FILM
R 16	RN55-00511	1	05905	SMA 0207 E 96	51.1 OHMS 1% MET FILM
R 17	RN55-02210	1	05905	SMA 0207 E 96	221 OHMS 1% MET FILM
R 18	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM

Parts List for 300 MHz OSC PCA No. 304CA05500 Rev. H

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
R 19	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 20	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 21	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 22	RN55-23740	1	05905	SMA 0207 E 96	37.4 K OHMS 1% MET FILM
R 23	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 24	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 25	RN55-00332	1	05905	SMA 0207 E 96	33.2 OHMS 1% MET FILM
R 26	RN55-01500	1	05905	SMA 0207 E 96	150 OHMS 1% MET FILM
R 27	RN55-00511	1	05905	SMA 0207 E 96	51.1 OHMS 1% MET FILM
R 28	RN55-02430	1	05905	SMA 0207 E 96	243 OHMS 1% MET FILM
U 1	URPO-78120	1	04713	MC78L12CP	MC78L12CP .1A 12V REG
U 2	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 3	URPO-78120	1	04713	MC78L12CP	MC78L12CP .1A 12V REG
U 4	URPO-78120	1	04713	MC78L12CP	MC78L12CP .1A 12V REG
U 5	URPO-78120	1	04713	MC78L12CP	MC78L12CP .1A 12V REG

Parts List for 8 POS LEVER SWITCH PCA No. 304CA02100 Rev. C

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF02100	1	58900	304CF02100	8 POS LEVER SWITCH PCB
DA	1	DSA8-02719	1	07263	FSA 2719P	FSA2719P 8 DIODES DIP
DA	2	DSA8-02719	1	07263	FSA 2719P	FSA2719P 8 DIODES DIP
DA	3	DSA8-02719	1	07263	FSA 2719P	FSA2719P 8 DIODES DIP
DA	4	DSA8-02719	1	07263	FSA 2719P	FSA2719P 8 DIODES DIP
P	1	JIA1-20430	1	52072	CAD20SP100230430	20 PIN STRIPLINE PLUG
R	1	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	2	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	3	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	4	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
S	1	101BC25400	1	58900	101BC25400	LEVER SWITCH-8 DIGIT
U	1	UCN0-05140	1	04713	MC14514BCP	MC14514 4 TO 16 DECODER

Parts List for M610 FREQ. DISPLAY PCA No. 304CA02602 Rev. B

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304BF02600	1	58900	304BF02600	FREQUENCY DISPLAY PCB
	2	JSPO-10018	2	09922	DILB18P-108	18 PIN DIP SOCKET
	3	HSTX-44004	2	88245	A1591B	4-40 CORNR BLOCK 1/16 MTL
	4	101BF05400	2	58900	101BF05400	DISPLAY MOUNT END
C	1	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
DS	1	IMFO-00090	1	F0001	9LT-03	9 DIGIT FLUOR DISPLAY
DS	2	ILGR-00200	1	58361	MV5253	GREEN LED .2" DIA
DS	3	ILGR-00200	1	58361	MV5253	GREEN LED .2" DIA
P	1	JIA1-26730	1	52072	CAD26SP100230730	26 PIN STRIPLINE PLUG
Q	1	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
Q	2	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
R	1	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	2	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R	3	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	4	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R	5	RN55-01820	1	05905	SMA 0207 E 96	182 OHMS 1% MET FILM
U	1	UINO-00594	1	18364	NE594N	NE594 8X DISP DRIVE
U	2	UINO-00594	1	18364	NE594N	NE594 8X DISP DRIVE

Parts List for 5 POS LEVER SWITCH PCA No. 304BA02500 Rev. B

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304BF02500	1	58900	304BF02500	5 POS LEVER SWITCH PCB
DA	1	DSA8-02719	1	07263	FSA 2719P	FSA2719P 8 DIODES DIP
DA	2	DSA8-02719	1	07263	FSA 2719P	FSA2719P 8 DIODES DIP
P	1	JIA1-20430	1	52072	CAD20SP100230430	20 PIN STRIPLINE PLUG
S	1	101BC12702	1	58900	101BC12702	5 POS LEVER SWITCH +/-

Parts List for MOD/PWR DISPLAY PCA No. 304DA02300 Rev. D

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF02300	1	58900	304CF02300	MOD/PWR DISPLAY PCB
	2	HSTX-44004	3	88245	A1591B	4-40 CORNR BLOCK 1/16 MTL
	3	101BF05400	4	58900	101BF05400	DISPLAY MOUNT END
	4	JSPO-10018	4	09922	DILB18P-108	18 PIN DIP SOCKET
	5	JSPO-10016	1	09922	DILB16P-108	16 PIN DIP SOCKET
	6	JSPO-10014	1	09922	DILB14P-108	14 PIN DIP SOCKET
C	1	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	2	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
DS	1	IMFO-00050	1	F0001	5LT-03	5 DIGIT FLUOR DISPLAY
DS	2	IMFO-00050	1	F0001	5LT-03	5 DIGIT FLUOR DISPLAY
DS	3	ILGR-00200	1	58361	MV5253	GREEN LED .2" DIA
P	1	JIA1-34730	1	52072	CAD34SP100230730	34 PIN STRIPLINE PLUG
Q	1	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
R	1	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	2	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R	3	RN55-12210	1	05905	SMA 0207 E 96	2.21 K OHMS 1% MET FILM
S	1	SLPO-00202	1	95146	CSS-022	DPDT PC MT SLIDE SWITCH
U	1	UCNO-00010	1	04713	MC14001BCP	MC14001 QUAD NOR
U	2	UINO-00594	1	18364	NE594N	NE594 8X DISP DRIVE
U	3	UCNO-05430	1	04713	MC14543P	MC14543P BCD TO 7 SEGMENT
U	4	UINO-00594	1	18364	NE594N	NE594 8X DISP DRIVE
U	5	UINO-00594	1	18364	NE594N	NE594 8X DISP DRIVE
U	6	UINO-00594	1	18364	NE594N	NE594 8X DISP DRIVE

Parts List for ADDRESS SWITCH ASSY No. 101BA04700 Rev. D

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	101BF04700	1	58900	101BF04700	ADDRESS SWITCH BD
2	SDP0-00501	1	71450	206-5	5 SPST DIP SWITCH
3	JSPR-10016	1	06776	ICN163S3T	16 PIN DIP CLIP SOCKET
4	JSPR-90016	1	06776	RC76	16 PIN RETAINER CLIP
5	HSTS-60304	2	06540	9532B-A-0632	6-32 X 3/16 SWAGE SPACER

Parts List for TEMP COMP PCA No. 304BA04600 Rev. E

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304BF04600	1	58900	304BF04600	TEMP COMP PCB
	2	ETSB-06216	8	88245	2000B	BIFURCATED TERMINAL 5/32
	3	HSCS-40203	3	55566	1531-A-4-A-7	#4 X 1/8 CLEAR SPACER
	4	ETST-06224	1	88245	1280B	TURRET TERMINAL
C	1	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	2	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	3	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	4	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	5	CT25-R7100	1	90201	TDM107M025L6	100 UF 25V TANTALUM
CR	1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	3	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
J	1	JSP0-10016	1	09922	DILB16P-108	16 PIN DIP SOCKET
P	1	JHP0-10016	1	51167	16-600-10	16 PIN DIP HEADER
Q	1	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
Q	2	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
R	1	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	2	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	3	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R	4	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	5	RN55-13160	1	05905	SMA 0207 E 96	3.16 K OHMS 1% MET FILM
R	6	RN55-32000	1	05905	SMA 0207 E 96	200 K OHMS 1% MET FILM
R	7	RN55-13920	1	05905	SMA 0207 E 96	3.92 K OHMS 1% MET FILM
R	8	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R	9	RAPF-22000	1	73138	66WR20K	20K 10% 20T VERT PC
R	10	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R	11	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R	12	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R	13	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
R	14	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
R	15	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
R	16	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
U	1	ULP0-00335	1	27014	LM335Z	TEMP. SENS
U	2	UON0-00074	1	01295	TL074CN	TL074CN QUAD FET OP AMP
U	3	URP0-78150	1	04713	MC78L15CP	MC78L15 .1A 15V REG
U	4	URP0-79150	1	04713	MC79L15CP	MC79L15 .1A -15V REG
VR	1	DRAE-00827	1	04713	1N827	IN827 6.2V REF. DIODE

Parts List for OSCILLATOR/MULT PCA No. 304CA05700 Rev. B

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF05700	1	58900	304CF05700	OSCILLATOR/MULT PCB
	2	101BF04300	1	58900	101BF04300	SAMPLER IF WALL
	3	304BF06300	1	58900	304BF06300	OSCILLATOR/MULT COVER
	4	304BF06400	1	58900	304BF06400	OSCILLATOR/MULT BASE
	5	304BF06500	1	58900	304BF06500	OSCILLATOR/MULT L. SIDE
	6	304BF06600	1	58900	304BF06600	OSCILLATOR/MULT R. SIDE
	7	304BF06700	1	58900	304BF06700	OSCILLATOR/MULT END PLATE
	8	304BF06800	1	58900	304BF06800	OSCILLATOR/MULT CONN MTG
	9	LFTO-83216	4	89110	859617-1	FEED-THRU FILTER 15A
	10	JRBM-00000	6	98291	51-045-0000	SMB M BULK MOUNT
	12	101BF04601	1	58900	101BF04601	SAMPLER IF SUPPORT,NOTCHE
	13	304BF05101	1	58900	304BF05101	MODULE WALL
	14	304BF05201	1	58900	304BF05201	MODULE SUPPORT
	15	HBHS-A2403	1	96906	MIL STD	10-24 X 3/16 SET SCREW
	16	HLST-21105	1	79963	341-.093	#2 SOLDER LUG
AR	1	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
C	1	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	2	CC50-00390	1	51642	150-100-C0G-390J	39 PF CERAMIC NPO
C	3	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	4	CV00-01012	1	18736	EF12	1-12 PF VARIABLE
C	5	CC50-00120	1	51642	150-100-C0G-120J	12 PF CERAMIC NPO
C	6	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
C	7	CC50-00330	1	52763	EDPT-33-NPO-5%	33 PF CERAMIC NPO
C	8	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	9	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	10	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	11	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	12	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	13	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	14	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	15	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C	16	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C	17	CV00-02011	1	74970	187-0106-005	1.7-11 PF AIR TRIMMER
C	18	CV00-09035	1	59660	538011D 9-35	9-35 PF VARIABLE
C	19	CC50-00100	1	51642	100-100-C0G-100J	10 PF CERAMIC NPO
C	20	CV00-02011	1	74970	187-0106-005	1.7-11 PF AIR TRIMMER
C	21	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	22	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	23	CV00-05018	1	59660	538011A 5.5-18	5.5-18 PF VARIABLE
C	25	CV00-05018	1	59660	538011A 5.5-18	5.5-18 PF VARIABLE
C	26	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	27	CV00-05018	1	59660	538011A 5.5-18	5.5-18 PF VARIABLE
C	28	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	29	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	30	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	31	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	33	CC50-01100	1	51642	150-100-C0G-101J	100 PF CERAMIC NPO
CR	1	DSA0-02810	1	28480	5082-2810	5082-2810 SCHOT. DIODE
CR	2	DVA0-00109	1	04713	MV109	MV109 6-30 PF DIODE
CR	3	DVA0-00109	1	04713	MV109	MV109 6-30 PF DIODE
L	1	LAD0-05270	1	72259	WEE-2.7	2.7 UH INDUCTOR

Parts List for OSCILLATOR/MULT PCA No. 304CA05700 Rev. B

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
L 2	LAD0-04150	1	72259	WEE-.15	.15 UH INDUCTOR
L 3	LR00-00000	1	58900		HAND WOUND COIL
L 4	LR00-00000	1	58900		HAND WOUND COIL
L 5	LR00-00000	1	58900		HAND WOUND COIL
L 6	LAD0-04150	1	72259	WEE-.15	.15 UH INDUCTOR
L 7	LR00-00000	1	58900		HAND WOUND COIL
L 8	LR00-00000	1	58900		HAND WOUND COIL
Q 1	QBNS-06304	1	04713	2N6304	2N6304 15V 1400MHZ NPN
R 1	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 2	RN55-14750	1	05905	SMA 0207 E 96	4.75 K OHMS 1% MET FILM
R 3	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 4	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 5	RN55-00562	1	05905	SMA 0207 E 96	56.2 OHMS 1% MET FILM
R 6	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 7	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 8	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 9	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 10	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 11	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 12	RN55-08250	1	05905	SMA 0207 E 96	825 OHMS 1% MET FILM
R 13	RN55-08250	1	05905	SMA 0207 E 96	825 OHMS 1% MET FILM
R 14	RN55-08250	1	05905	SMA 0207 E 96	825 OHMS 1% MET FILM
R 15	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 16	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 17	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 18	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 20	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 21	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
U 1	UEN0-10216	1	04713	MC10216P	MC10216P TRIPLE RCVR
U 2	UEN1-10107	1	04713	MC10H107P	MC10H107P TRI OR/NOR
U 3	URP0-78120	1	04713	MC78L12CP	MC78L12CP .1A 12V REG
U 4	URC0-07815	1	04713	MC7815CT	MC7815CT 1A 15V REG
U 5	UEN0-10216	1	04713	MC10216P	MC10216P TRIPLE RCVR
U 6	UEN0-10216	1	04713	MC10216P	MC10216P TRIPLE RCVR
Y 1	Y180-11000	1	00809	C189-1	110MHZ 5TH OVTN XTAL
YH 1	Y18H-00150	1	12020	PCL1-43-15-60	15V HC18 XTAL OVEN

Parts List for EXT ALC POT/SW M600 PCA No. 304BA09000 Rev. C

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304BF09000	1	58900	304BF09000	EXT ALC POT/SW M600 PCB
	2	ETSB-06216	8	88245	2000B	BIFURCATED TERMINAL 5/32
	3	STWO-00102	1	09353	7101-P4-D	SPDT TOGGLE SWITCH
R	1	RAPF-15000	1	73138	66WR5K	5K 10% 20T VERT PC
R	2	RAPF-22000	1	73138	66WR20K	20K 10% 20T VERT PC
R	3	RN56-21000	1	60393	GP 1/4 TC 25	10.0 K OHMS 1% MET FILM

Parts List for MODULATION CONTROL PCA No. 308DA00301 Rev. J

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	308CF00301	1	58900	308CF00301	MODULATION CONTROL PCB
	2	ETSB-06216	10	88245	2000B	BIFURCATED TERMINAL 5/32
C	1	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	2	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	3	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	4	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	5	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	6	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	7	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	8	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	9	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	10	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	11	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	12	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	15	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	16	CC50-03470	1	51642	150-100-W5R-473	.047 UF CERAMIC X7R
C	17	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	18	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	19	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	20	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	21	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	22	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	23	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	24	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	25	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	26	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
CR	1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	3	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	4	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	5	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	6	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	7	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	8	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	9	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	10	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	11	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	12	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	13	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	14	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	15	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	16	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
J	1	JRBM-00101	1	98291	51-053-0000	SMB M RTANG PC MOUNT
J	2	JRBM-00101	1	98291	51-053-0000	SMB M RTANG PC MOUNT
J	3	JRBM-00101	1	98291	51-053-0000	SMB M RTANG PC MOUNT
J	6	JRBM-00101	1	98291	51-053-0000	SMB M RTANG PC MOUNT
P	2	JIA1-16630	1	52072	CAD16SP100430630	16 PIN STRIPLINE PLUG
P	3	JIA1-26730	1	52072	CAD26SP100230730	26 PIN STRIPLINE PLUG
Q	1	QBNS-04275	1	27014	PN4275	PN4275 .1A 15V .6W NPN
Q	2	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q	3	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP

Parts List for MODULATION CONTROL PCA No. 308DA00301 Rev. J

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
Q 4	QBNS-04275	1	27014	PN4275	PN4275 .1A 15V .6W NPN
Q 5	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q 6	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q 7	QBNS-04275	1	27014	PN4275	PN4275 .1A 15V .6W NPN
Q 8	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q 9	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q 10	QBPS-04258	1	27014	PN4258	PN4258 12V 700MHZ PNP
Q 11	QBNS-04275	1	27014	PN4275	PN4275 .1A 15V .6W NPN
Q 12	QBNS-04275	1	27014	PN4275	PN4275 .1A 15V .6W NPN
Q 14	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
R 1	RN55-01500	1	05905	SMA 0207 E 96	150 OHMS 1% MET FILM
R 2	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 3	WJIB-05022	1	A0003	923345-05	.5" INSULATED JUMPER
R 4	RN55-01500	1	05905	SMA 0207 E 96	150 OHMS 1% MET FILM
R 5	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 6	WJIB-05022	1	A0003	923345-05	.5" INSULATED JUMPER
R 7	RN55-01500	1	05905	SMA 0207 E 96	150 OHMS 1% MET FILM
R 8	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 9	WJIB-05022	1	A0003	923345-05	.5" INSULATED JUMPER
R 10	RN55-06650	1	05905	SMA 0207 E 96	665 OHMS 1% MET FILM
R 11	RN55-01210	1	05905	SMA 0207 E 96	121 OHMS 1% MET FILM
R 12	RN55-06650	1	05905	SMA 0207 E 96	665 OHMS 1% MET FILM
R 13	RN55-01210	1	05905	SMA 0207 E 96	121 OHMS 1% MET FILM
R 14	RN55-06650	1	05905	SMA 0207 E 96	665 OHMS 1% MET FILM
R 15	RN55-01210	1	05905	SMA 0207 E 96	121 OHMS 1% MET FILM
R 16	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 17	RN55-04750	1	05905	SMA 0207 E 96	475 OHMS 1% MET FILM
R 18	RN55-00182	1	05905	SMA 0207 E 96	18.2 OHMS 1% MET FILM
R 19	RAPD-11000	1	73138	89PR1K	1K POT 15T PC MNT
R 20	RAPD-31000	1	73138	89PR100K	100K POT 15T PC MNT
R 21	RAPD-31000	1	73138	89PR100K	100K POT 15T PC MNT
R 22	RN55-15620	1	05905	SMA 0207 E 96	5.62 K OHMS 1% MET FILM
R 23	RN55-15620	1	05905	SMA 0207 E 96	5.62 K OHMS 1% MET FILM
R 24	RC05-05600	1	01121	RC05GF561-J	560 OHM 5% 1/8W CARBON
R 25	RC05-11000	1	01121	BB-102-5	1.0K; 5% 1/8W CARBON
R 26	RC05-06800	1	01121	BB-681-5	680ohm; 5% 1/8W CARBON
R 27	RC05-01000	1	01121	BB-101-5	100ohms;5% 1/8W CARBON
R 28	RC05-03300	1	01121	BB-331-5	330ohms 5% 1/8W CARBON
R 29	RN55-11500	1	05905	SMA 0207 E 96	1.5 K OHMS 1% MET FILM
R 30	RN55-21500	1	05905	SMA 0207 E 96	15 K OHMS 1% MET FILM
R 31	RN55-28250	1	05905	SMA 0207 E 96	82.5 K OHMS 1% MET FILM
R 32	RN55-22550	1	05905	SMA 0207 E 96	25.5 K OHMS 1% MET FILM
R 33	RAPD-15000	1	73138	89PR5K	5K POT 15T PC MNT
R 34	RN55-14990	1	05905	SMA 0207 E 96	4.99 K OHMS 1% MET FILM
R 35	RAPD-15000	1	73138	89PR5K	5K POT 15T PC MNT
R 36	RAPD-15000	1	73138	89PR5K	5K POT 15T PC MNT
R 37	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 38	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 39	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 40	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 41	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM

Parts List for MODULATION CONTROL PCA No. 308DA00301 Rev. J

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
R 42	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 43	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 44	RN55-00511	1	05905	SMA 0207 E 96	51.1 OHMS 1% MET FILM
R 45	RN55-06040	1	05905	SMA 0207 E 96	604 OHMS 1% MET FILM
R 46	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
R 47	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 48	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 49	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 51	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 53	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 54	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 55	RAPA-15000	1	01121	SPPN116P502U	5K 375W X 1.16
R 56	RAPA-15000	1	01121	SPPN116P502U	5K 375W X 1.16
R 57	RC05-11000	1	01121	BB-102-5	1.0K; 5% 1/8W CARBON
R 59	RC05-34700	1	01121	BB-474-5	470 K 5% 1/8W CARBON
R 60	RC05-34700	1	01121	BB-474-5	470 K 5% 1/8W CARBON
R 61	RC05-21000	1	01121	BB-103-5	10K; 5% 1/8W CARBON
R 62	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 63	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 64	RN55-03320	1	05905	SMA 0207 E 96	332 OHMS 1% MET FILM
R 66	RC05-21000	1	01121	BB-103-5	10K; 5% 1/8W CARBON
R 107	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
R 108	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
R 109	RN55-?????	1	05905	SMA 0207 E 96	SELECTED IN TEST
RM 1	RM7S-05600	1	71450	750-81-R560	560 OHM X 7 SIP NETWRK
RM 2	RM7S-12200	1	71450	750-81-R2.2K	2.2KOHM X 7 SIP NETWRK
S 1	SFP0-00102	1	09353	7103-J2-V8	ROCKER SWITCH
S 2	SFP0-00102	1	09353	7103-J2-V8	ROCKER SWITCH
S 3	SFP0-00102	1	09353	7103-J2-V8	ROCKER SWITCH
U 1	UEN0-10105	1	04713	MC10105P	MC10105P TRIPLE OR/NOR
U 2	UIN0-01413	1	04713	MC1413P	MC1413P X7 DRIVER .5A
U 3	UEN0-10105	1	04713	MC10105P	MC10105P TRIPLE OR/NOR
U 4	UON0-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 5	URP0-78150	1	04713	MC78L15CP	MC78L15 .1A 15V REG
U 6	URP0-79150	1	04713	MC79L15CP	MC79L15 .1A -15V REG
U 7	UGN0-08038	1	32293	ICL 8038 CC JD	ICL8038 WAVEFORM GEN.
U 8	UCN0-05550	1	04713	MC14555BCP	MC14555BCP DUAL 1 OF 4
U 9	UTN0-01381	1	01295	SN74LS138N	SN74LS138N 3 TO 8 DEC
U 10	UCN0-00010	1	04713	MC14001BCP	MC14001 QUAD NOR
U 11	ULN0-05053	1	32293	IH5053CJE	IH5053 QUAD ANALOG SWITCH
U 12	UTN0-02372	1	04713	74HC237N	74HC237N 1 OF 8 DECODER
U 13	UCN0-00760	1	04713	MC14076BCP	MC14076BCP 4 BIT LATCH
U 14	UCN0-00760	1	04713	MC14076BCP	MC14076BCP 4 BIT LATCH
U 15	UTN0-01752	1	04713	74HC175N	74HC175N QUAD D FLIP-FLOP
U 16	ULN0-05053	1	32293	IH5053CJE	IH5053 QUAD ANALOG SWITCH
U 17	UON0-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP

Parts List for M600 DWNCONV. PLL PCA No. 304CA11600 Rev. D

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF11600	1	58900	304CF11600	M600 DWNCONV. PLL PCB
	2	ETSB-06216	15	88245	2000B	BIFURCATED TERMINAL 5/32
	3	ETST-06224	1	88245	1280B	TURRET TERMINAL
C	1	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
C	2	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	3	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	4	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	5	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	6	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	7	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C	8	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	9	CC50-02150	1	51642	200-050-NP0-152J	1500PF CERAMIC NP0
C	10	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	11	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	12	CC50-02150	1	51642	200-050-NP0-152J	1500PF CERAMIC NP0
C	13	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	14	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	15	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	16	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	17	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	18	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	19	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	20	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	21	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	22	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	23	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	24	CE63-07220	1	56289	501D227F063PR	220 UF 63V ELECT.
CR	1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	3	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
CR	4	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
CR	5	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
CR	6	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
CR	7	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	8	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	9	DZAD-04753	1	04713	1N4753	IN4753 36 V ZENER
CR	10	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
CR	11	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
CR	12	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
DS	1	ILRR-00125	1	58361	MV5077C	RED LED 1/8" DIA
J	1	JRBM-00101	1	98291	51-053-0000	SMB M RTANG PC MOUNT
J	2	JRBM-00101	1	98291	51-053-0000	SMB M RTANG PC MOUNT
J	3	JRBM-00101	1	98291	51-053-0000	SMB M RTANG PC MOUNT
Q	1	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
Q	2	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q	3	QBPP-05193	1	04713	2N5193	2N5193 4A 40V 40W PNP
R	1	RN55-00681	1	05905	SMA 0207 E 96	68.1 OHMS 1% MET FILM
R	2	RN55-02210	1	05905	SMA 0207 E 96	221 OHMS 1% MET FILM
R	3	RN55-01300	1	05905	SMA 0207 E 96	130 OHMS 1% MET FILM
R	4	RN55-00825	1	05905	SMA 0207 E 96	82.5 OHMS 1% MET FILM
R	5	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM

Parts List for M600 DWNCONV. PLL PCA No. 304CA11600 Rev. D

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
R 6	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 7	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 8	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 9	RN55-13010	1	05905	SMA 0207 E 96	3.01 K OHMS 1% MET FILM
R 10	RN55-13010	1	05905	SMA 0207 E 96	3.01 K OHMS 1% MET FILM
R 11	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 12	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 13	RN55-21150	1	05905	SMA 0207 E 96	11.5 K OHMS 1% MET FILM
R 14	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 15	RN55-21150	1	05905	SMA 0207 E 96	11.5 K OHMS 1% MET FILM
R 16	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 17	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 18	RN55-12740	1	05905	SMA 0207 E 96	2.74 K OHMS 1% MET FILM
R 19	RN55-22490	1	05905	SMA 0207 E 96	24.9 K OHMS 1% MET FILM
R 20	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 21	RN55-22490	1	05905	SMA 0207 E 96	24.9 K OHMS 1% MET FILM
R 22	RN55-24750	1	05905	SMA 0207 E 96	47.5 K OHMS 1% MET FILM
R 23	RN55-31500	1	05905	SMA 0207 E 96	150 K OHMS 1% MET FILM
R 24	RN55-31500	1	05905	SMA 0207 E 96	150 K OHMS 1% MET FILM
R 25	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 26	RN55-41000	1	05905	SMA 0207 E 96	1 M OHMS 1% MET FILM
R 27	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 29	RAPF-22000	1	73138	66WR20K	20K 10% 20T VERT PC
R 30	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 31	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 32	RN55-22800	1	05905	SMA 0207 E 96	28 K OHMS 1% MET FILM
R 33	RN55-21500	1	05905	SMA 0207 E 96	15 K OHMS 1% MET FILM
R 34	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 35	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 36	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 37	RN55-03920	1	05905	SMA 0207 E 96	392 OHMS 1% MET FILM
R 38	RN55-03920	1	05905	SMA 0207 E 96	392 OHMS 1% MET FILM
R 39	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 40	RN55-01000	1	05905	SMA 0207 E 96	100 OHMS 1% MET FILM
R 41	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 42	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 43	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
U 1	UENO-12040	1	04713	MC12040P	MC12040P PHASE/FREQ DET
U 2	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 3	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 4	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 5	UONO-05532	1	18324	NE5532N	DUAL;OP AMP;10MHz
U 6	UONO-05532	1	18324	NE5532N	DUAL;OP AMP;10MHz
VR 1	DRAE-00827	1	04713	1N827	IN827 6.2V REF. DIODE

Parts List for BUFFER MODULE PCA No. 304BA12100 Rev. C

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304BF12100	1	58900	304BF12100	BUFFER MODULE PCB
	2	304BF12600	1	58900	304BF12600	BUFFER MODULE MOUNT
	3	304CF09601	1	58900	304CF09601	BOTTOM PC BD SHIELD 1.5 X
	4	304CF09301	1	58900	304CF09301	TOP PC BD SHIELD 1.5 X 1.
	5	304BF09400	1	58900	304BF09400	PC BD SHIELD COVER
	6	JRBM-00000	4	98291	51-045-0000	SMB M BULK MOUNT
	7	LFTO-83208	1	89110	859640-1	FEED-THRU FILTER 15A
AR	1	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
AR	2	MA19-00001	1	24539	MSA-0135-12	0-250MHZ AMP 19DB 1.5DBM
C	1	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	2	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
C	3	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	4	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	5	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	6	CK50-03100	1	96733	SG133BX103KS	.01 UF X7R CHIP
R	1	RC05-06800	1	01121	BB-681-5	680ohm; 5% 1/8W CARBON
R	2	RC05-06800	1	01121	BB-681-5	680ohm; 5% 1/8W CARBON
U	1	URP0-78120	1	04713	MC78L12CP	MC78L12CP .1A 12V REG

Parts List for M610 PUSH BUTTON SW PCA No. 309CA00200 Rev. E

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	309CF00200	1	58900	309CF00200	M610 PUSH BUTTON SW PCB
2	SPPL-22100	26	I0002	39-22100-ASSY	PUSH BUTTON SWITCH
3	SPPL-22500	2	I0002	39-22500-ASSY	PUSH BUTTON SWITCH
4	SPPL-22502	2	I0002	80-3990107	SWITCH;PLAIN CAP
5	309BC00300	1	58900	309BC00300	M610 PB SW RIBBON CABLE
6	ILRR-10125	26	28480	HLMP-K101	RED LED 1/8" DIA

Parts List for SWEEP BUSS PCA No. 309CA01900 Rev. C

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	309BF01900	1	58900	309BF01900	SWEEP BUSS PCB
	2	JPPO-20030	5	31781	345-060-524-202	60 PIN PC EDGE CONN
	3	309BC02000	1	58900	309BC02000	SWEEP BUS RIBBON CABLE
W	1	WJIB-05022	1	A0003	923345-05	.5" INSULATED JUMPER

DIAGRAMS

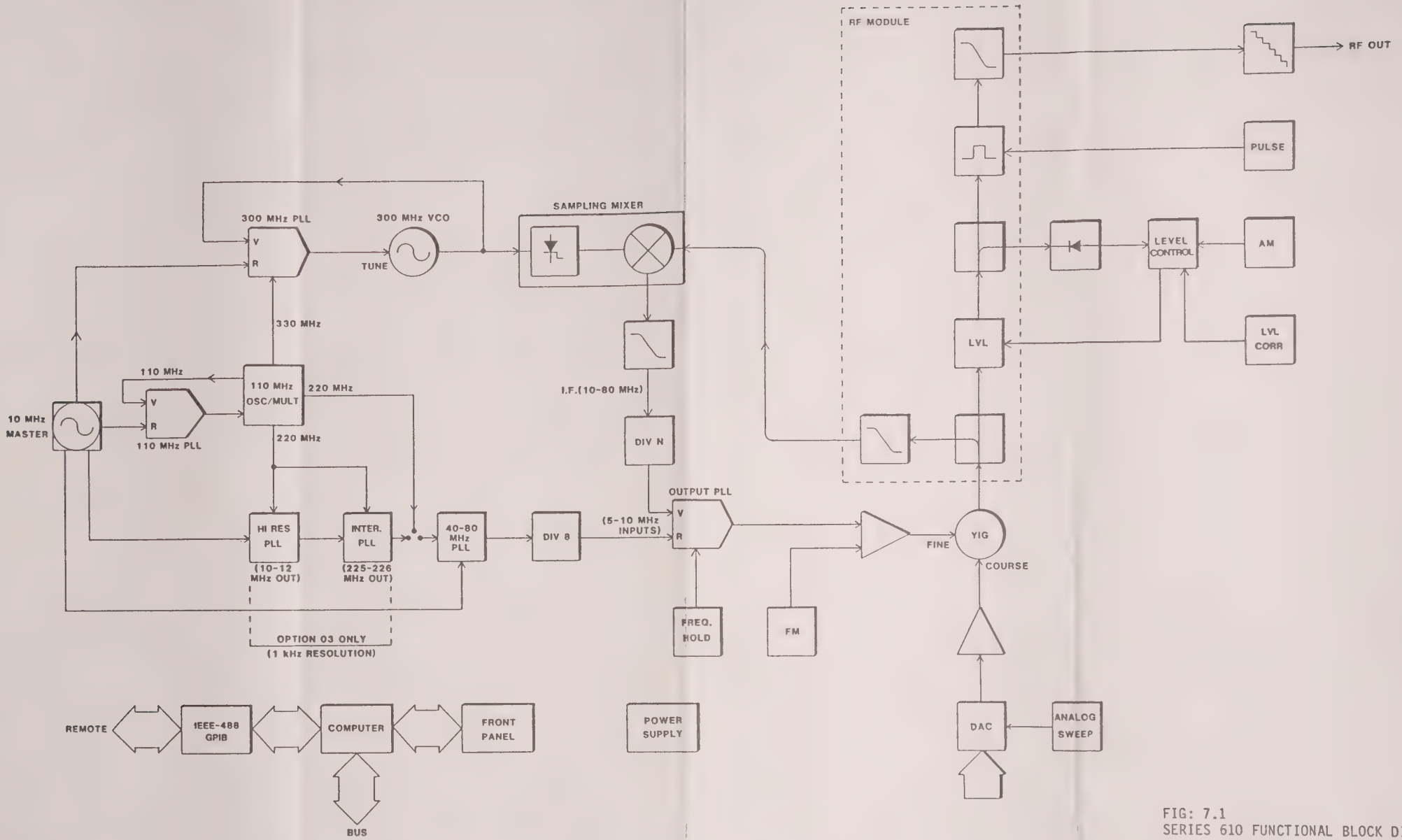


FIG: 7.1
SERIES 610 FUNCTIONAL BLOCK DIAGRAM
DWG# 309DD02200

REV A

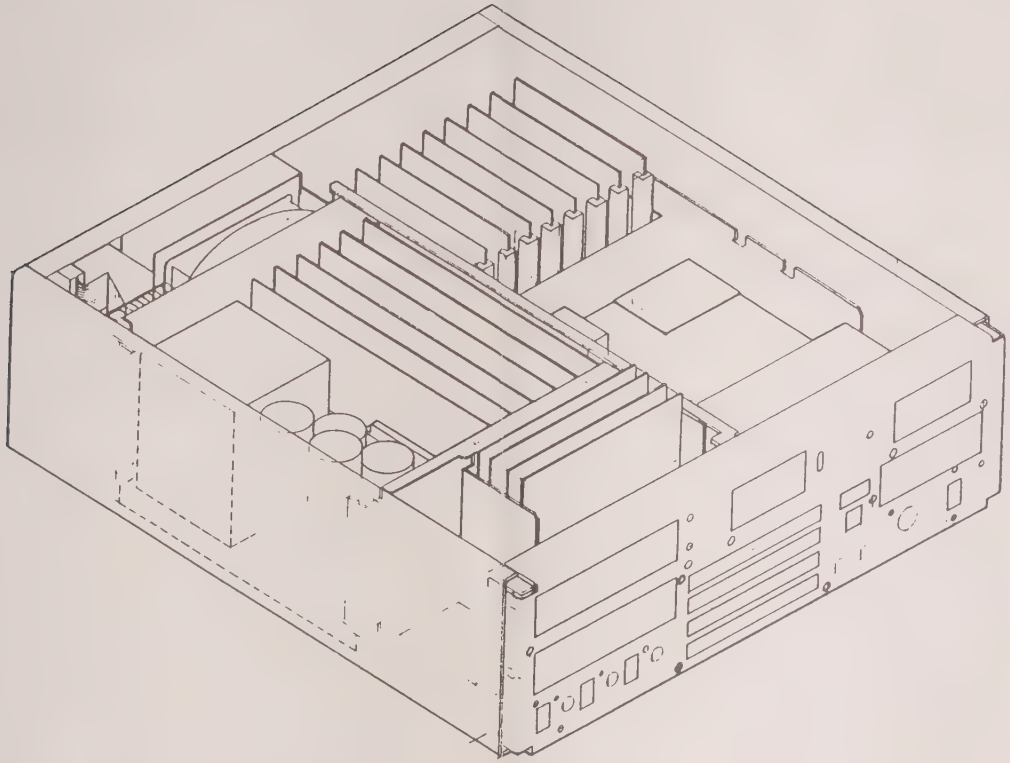


FIG: 7.2
SERIES 610 TEST ASSY
DWG# 309DA00800 SHT 1

REV A

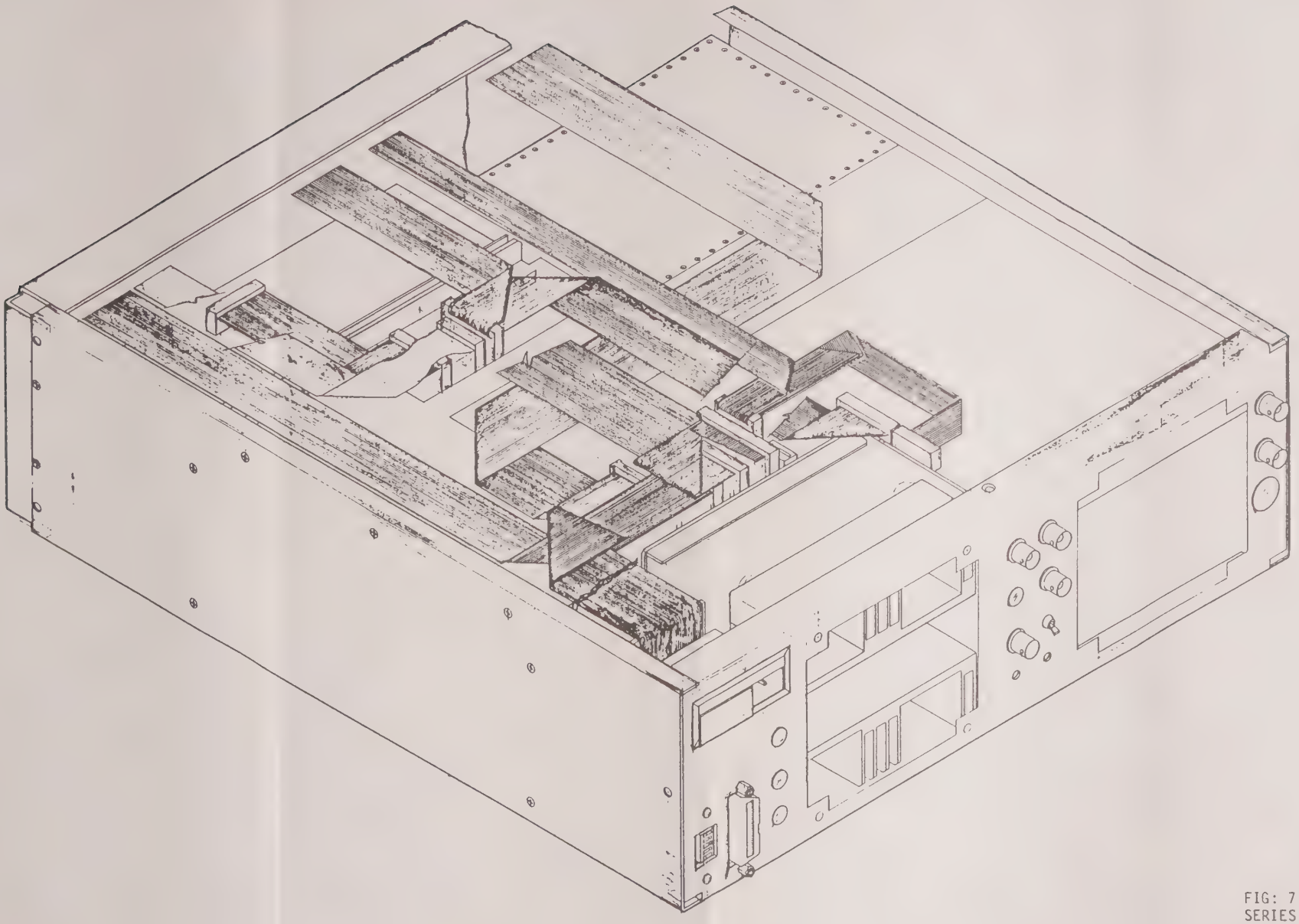
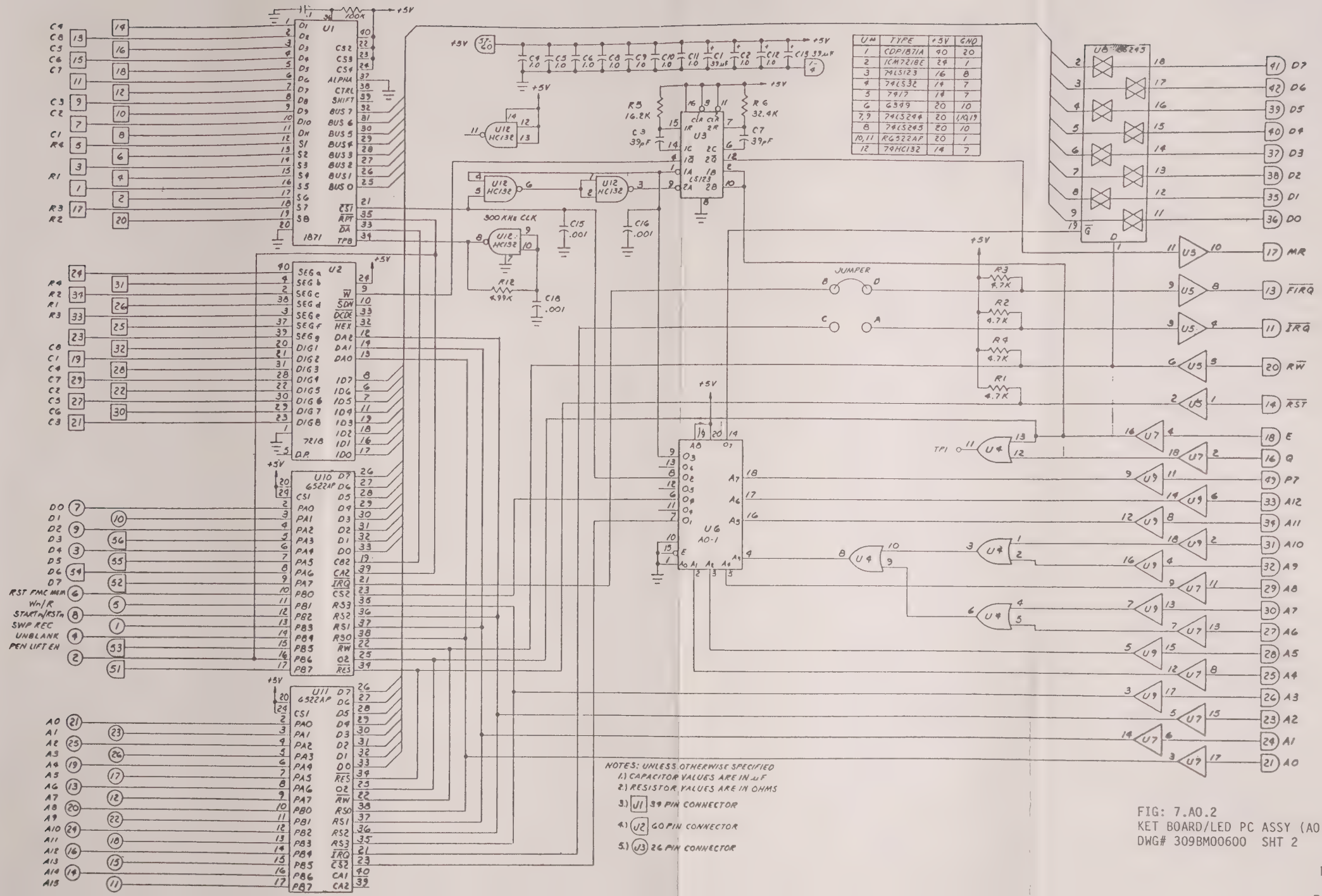


FIG: 7.3
SERIES 610 TEST ASSY
DWG# 309DA00800 SHT 2



UM	TYPE	+5V	GND
1	CDP1871A	40	20
2	ICM7218E	28	1
3	74LS123	16	8
4	74LS32	14	7
5	7917	1	7
6	6349	20	10
7,9	74LS244	20	1,10,19
8	74LS245	20	10
10,11	RG522AP	20	1
12	74HC132	14	7

NOTES: UNLESS OTHERWISE SPECIFIED
1.) CAPACITOR VALUES ARE IN μF
2.) RESISTOR VALUES ARE IN OHMS
3.) U1 39 PIN CONNECTOR
4.) U2 60 PIN CONNECTOR
5.) U3 26 PIN CONNECTOR

FIG: 7.AO.2
KET BOARD/LED PC ASSY (AO)
DWG# 309BM00600 SHT 2

REV D

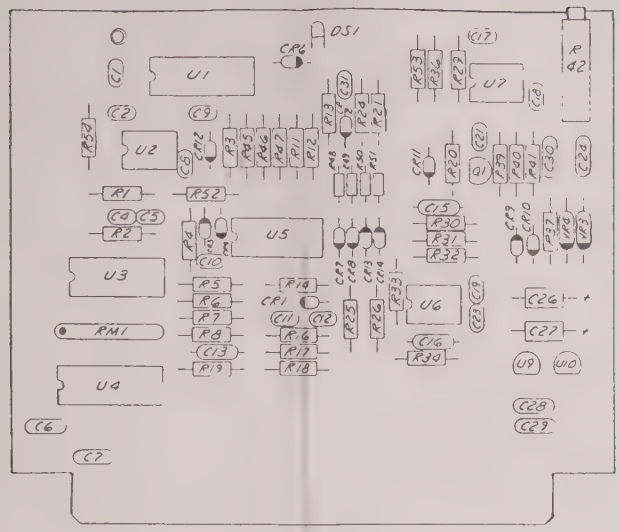


FIG: 7.A6.1
OUTPUT PLL PC ASSY (A6)
DWG# 304BM01001 SHT 1

REV C

OUTPUT PLL -- Circuit Board A6

This circuit produces a control signal for use in fine-tuning the instrument's YIG oscillator, in order to phase lock the YIG frequency to the master reference. In the FM mode, the control signal is combined with a modulation input.

The phase detector (U3) receives two input frequencies, both of which are in the 5-10 MHz range; when the loop is locked these frequencies are equal. The reference frequency input (fR) comes from the divide by 8 circuit on the divider board (A7), and the variable frequency input (fV) comes from the divide by N circuit on the same board. The phase detector produces outputs at pins 3 and 12 of U3; if the input frequencies are not in phase, wide pulses appear at one of these pins, depending on whether fV is leading or lagging. The outputs are used by the lock detector circuit (see U5-7, Q1) to determine whether the loop is locked. They are also used by one of two independent loop amplifier circuits (selected by analog gate U1) to produce the loop's control output.

The first loop amplifier circuit is used when the instrument is not in FM mode. The phase detector outputs are amplified by U5-1 and U5-14; frequency compensation networks (R8/C10, R5/C5, R3/C9) provide the rolloff needed to stabilize the loop. Diodes in the feedback loops of the amplifiers limit the amplifier outputs in order to prevent saturation during search. The output of U5-14 is applied (through the analog gate, U1) to the output amplifier, U2-1. This output is used by the FM driver (see A103) to tune the YIG oscillator's FM coil; it goes more negative to increase frequency and more positive to decrease.

The second loop amplifier circuit is used when the instrument is in the FM mode. Essentially, it duplicates the first loop amplifier (see U6-1, U6-7) but adds the input FM signal (amplified by U8-7) to the phase detector output signal. The two signals are combined by U7-1 and applied to analog gate U1.

The variable frequency input to the phase detector is derived from the sampling mixer's IF, not directly from the YIG output frequency. The sampler's IF is the product of a harmonic multiplier, and may be derived from the wrong harmonic. In that case the phase lock loop is misdirected, tuning the YIG oscillator in the wrong direction until it reaches its "+" or "-" rail. To prevent the PLL circuit from becoming stuck in this mode, a search circuit is added. This consists of amplifiers U5-8 and U2-7, which monitor the circuit output and return control voltages to the loop amplifier circuits. When the output becomes too positive (minimum frequency), U5-8 swings to its negative rail, driving the output negative (maximum frequency). When the situation is reversed, U2-7 drives the output positive (minimum frequency).

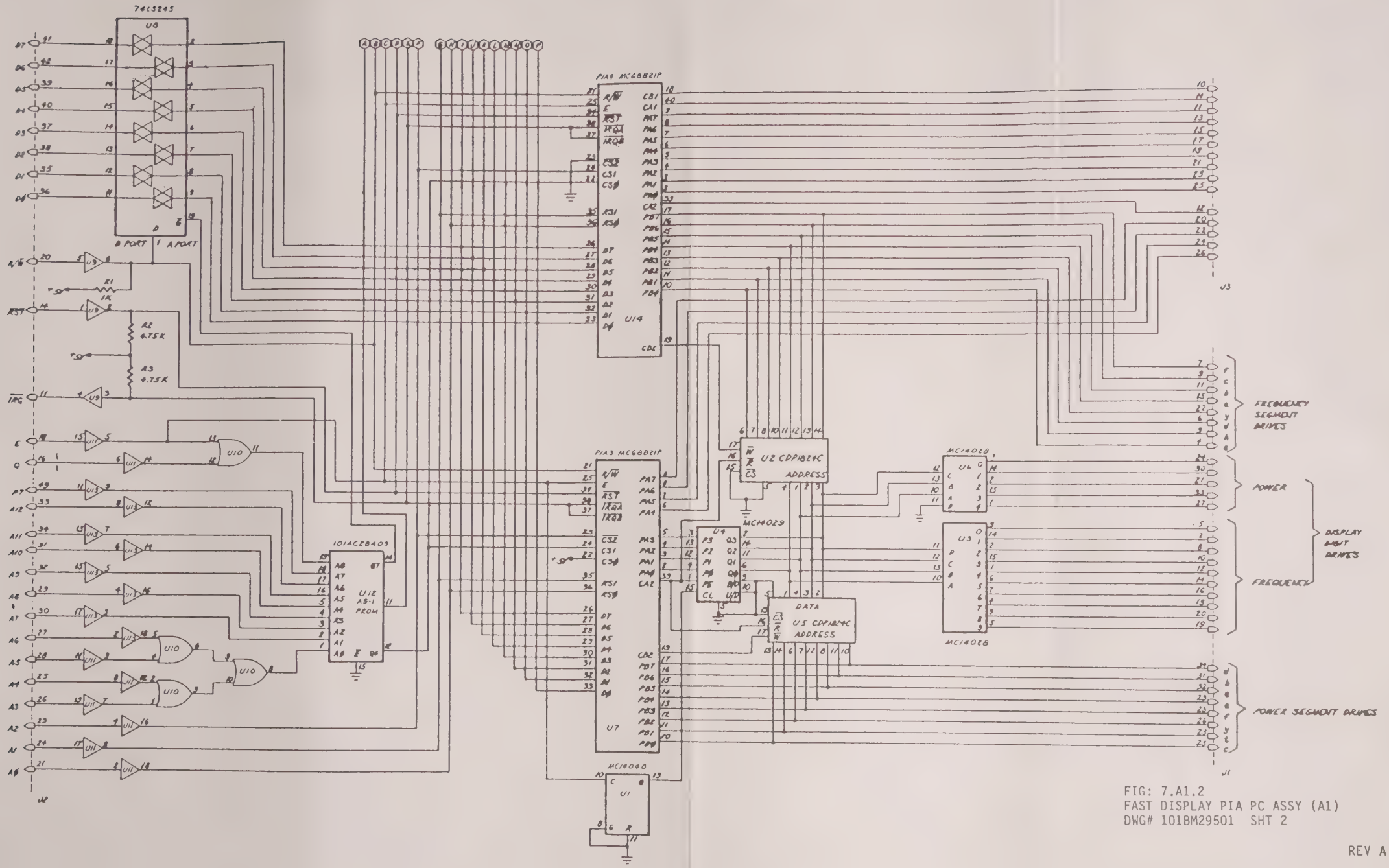
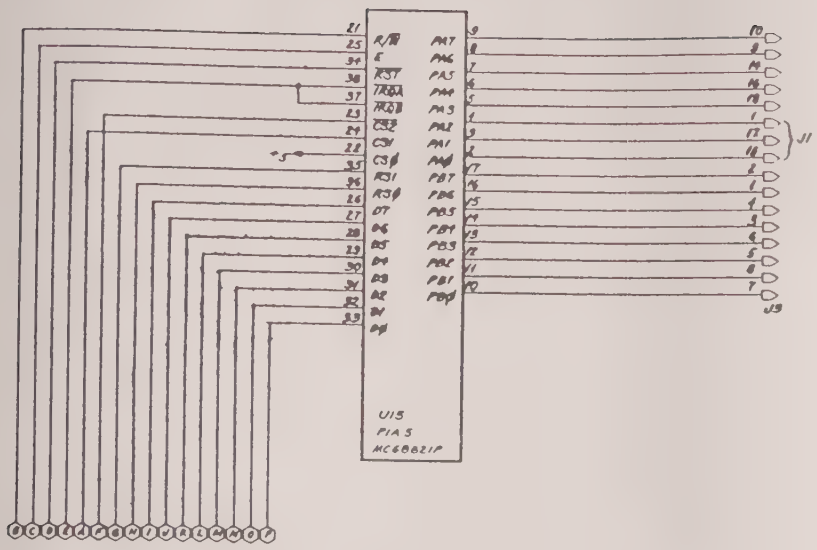


FIG: 7.A1.2
FAST DISPLAY PIA PC ASSY (A1)
DWG# 101BM29501 SHT 2

REV A



NOTES:
UNLESS NOTED OTHERWISE:
1. RESISTORS IN OHMS
2. CAPACITORS IN μF

U#	TYPE	+5	GND
1	MC14040	16	8
2, 5	CD4012A	14	7
3, 6	MC14020	16	8
4	MC14029	16	8
7, M, 15	MC6821P	20	1
8	74LS245	20	10
9	7417	14	7
10	74LS32	14	7
11, 13	74LS244	20	1, 10, 19
12	AB-1	20	10

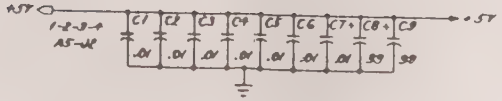


FIG: 7.A1.3
FAST DISPLAY PIA PC ASSY (A1)
DWG# 101BM29501 SHT 3

REV A

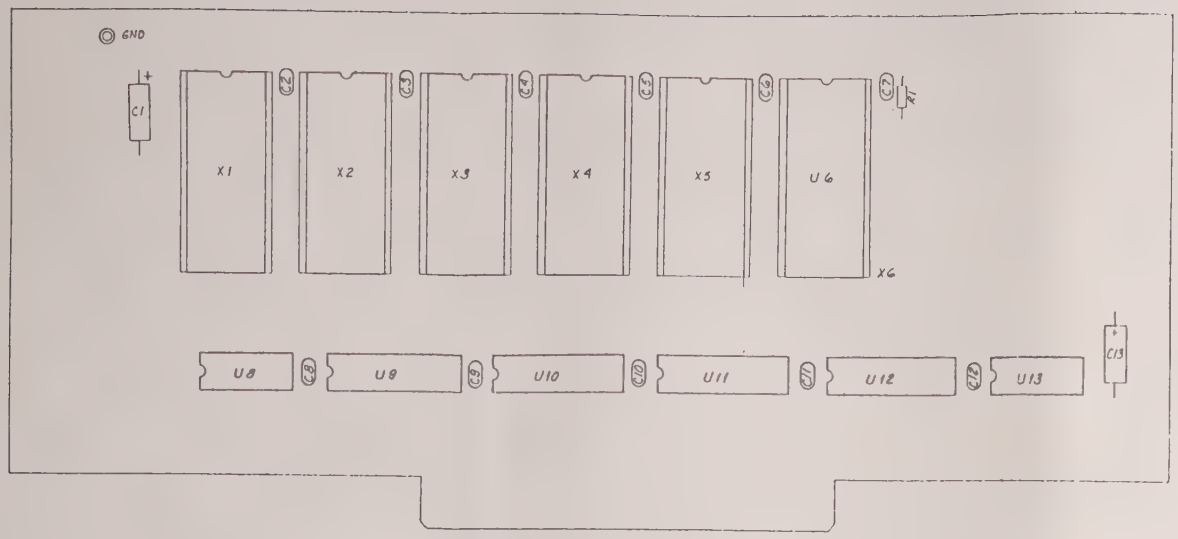


FIG: 7.A2.1
MEMORY PC ASSY (A2)
DWG# 101BM35702 SHT 1

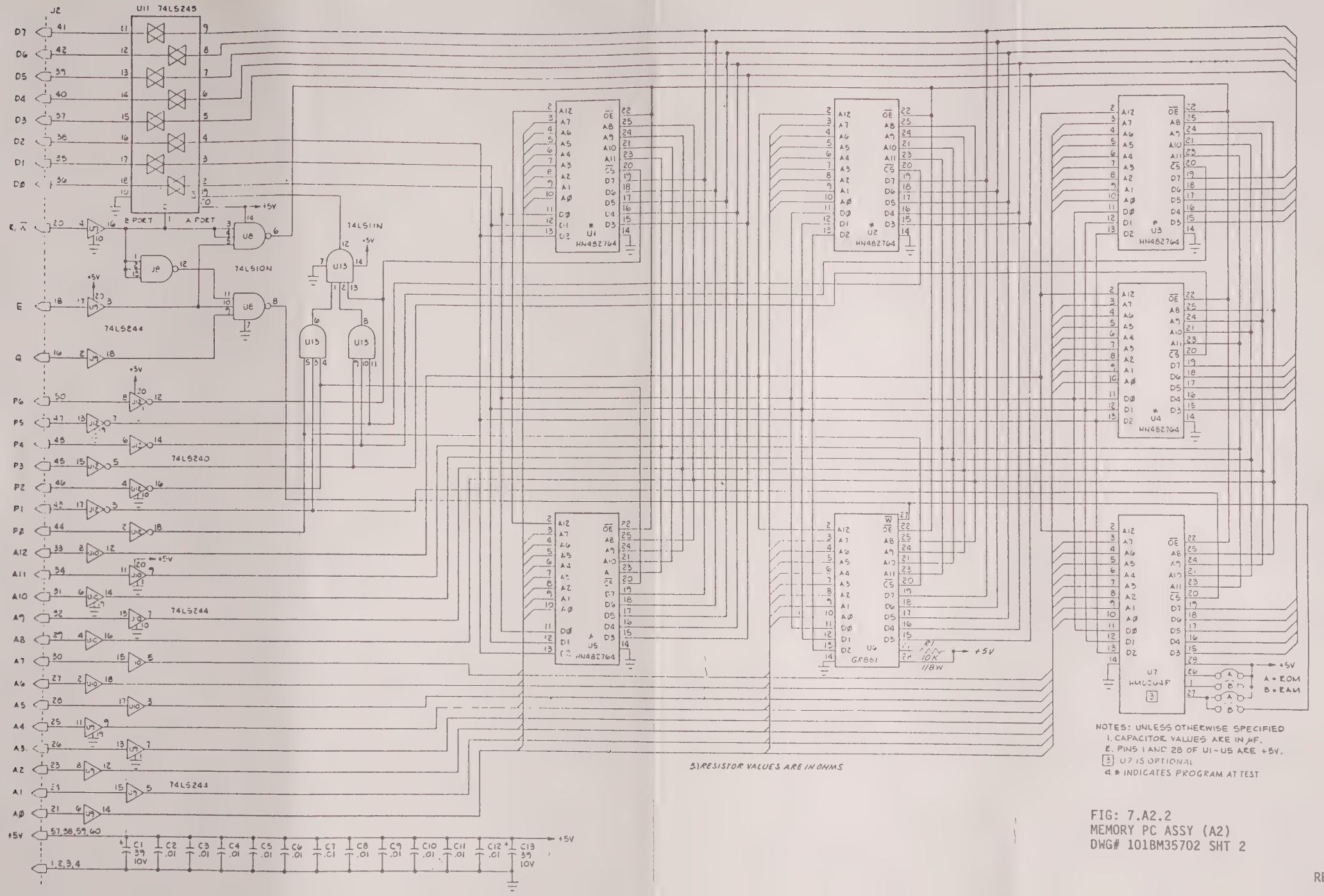
REV B

COMPUTER MEMORY -- Circuit Board A2

This circuit board can hold up to five programmable read-only memory ICs (U1 through U5), each having a capacity of 8K bytes. The PROMs hold the instrument's operational software. The amount of memory actually used is variable among individual instruments, depending on the frequency range, options, and special modifications implemented. The board also houses two RAM ICs (U6, U7), each having a capacity of 8K bytes. The remaining 8K bytes of the microprocessor's addressing capacity is taken up by the "reset" PROM on the CPU board and by input/output ports.

A bi-directional buffer (U11) interconnects the computer's 8-bit data bus with the memory devices. The computer's address bus and some control lines are buffered by U9, U10 and U12. Logic gates U8 and U13 decode some of these inputs in order to derive control signals for the memories and for the bi-directional buffer. The computer uses page lines P0 through P6 to select individual memory chips.

The address and data buses of the memory ICs are all connected in parallel; this is possible because the ICs have tri-state outputs (the outputs enter a high impedance state when the chip is de-selected).



NOTES: UNLESS OTHERWISE SPECIFIED
1. CAPACITOR VALUES ARE IN μF.
2. PINS 1 AND 28 OF U1-U5 ARE +5V.
3. RESISTOR VALUES ARE IN OHMS
[3] U7 IS OPTIONAL
4. * INDICATES PROGRAM AT TEST

FIG: 7.A2.2
MEMORY PC ASSY (A2)
DWG# 101BM35702 SHT 2

REV B

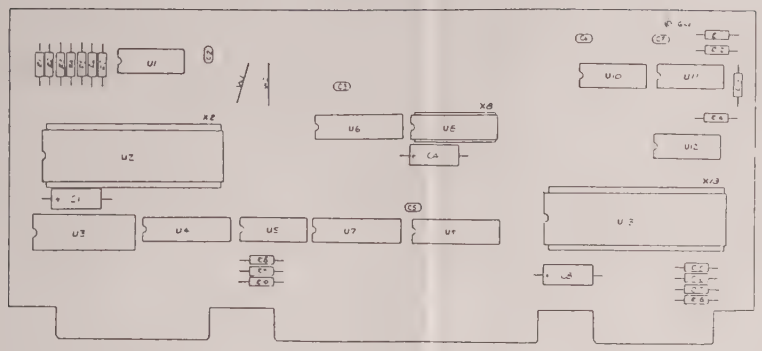


FIG: 7.A3.1
FAST IEEE PIA PC ASSY (A3)
DWG# 1018M06701 SHT 1

REV A

FAST IEEE-488 INTERFACE -- Circuit Board A3

GENERAL

This portion of the system computer provides communication between the microprocessor and any external controller using the IEEE-488 general purpose interface bus (GPIB). The circuit board also houses a peripheral interface adapter (PIA) which is used for a variety of instrument control functions.

COMPUTER BUS

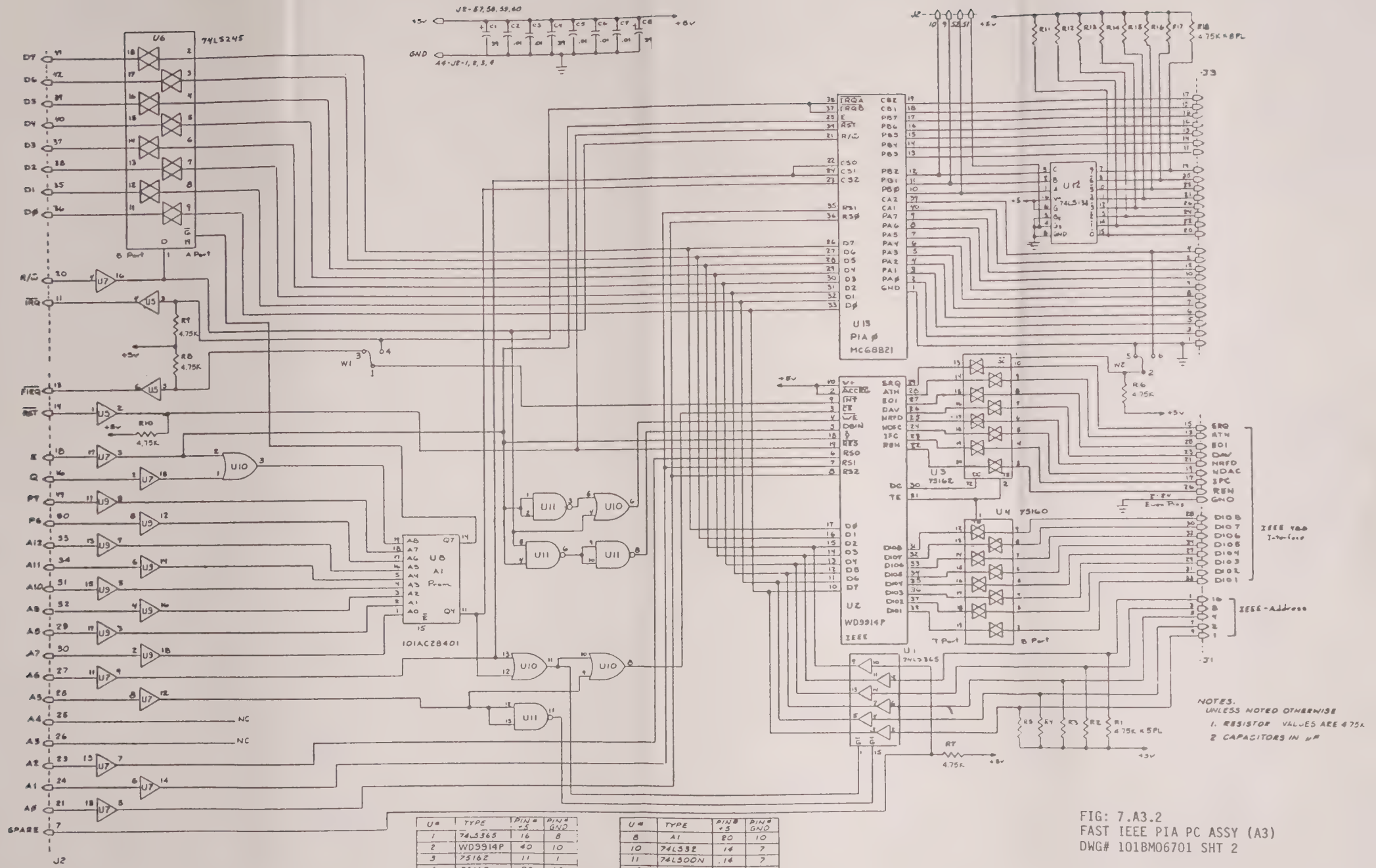
A bidirectional buffer (IC6) is used to interconnect the computer's 8-bit data bus with the PIA and GPIB devices. The computer's address bus and some control lines are buffered by IC5, IC7 and IC9, and are decoded by a high speed bipolar PROM, IC8, and by additional logic gates. The outputs of the decoder PROM are used to drive chip select lines on the PIA and GPIB devices and also to drive the data direction gate of the buffer (IC6).

IEEE-488 INTERFACE

The GPIB adapter (IC2) facilitates communication between the IEEE-488 interface bus and the system computer's data bus. It processes the general "interface" messages received from the controller, and transmits device-dependent messages (such as commands addressed specifically to this instrument) to the computer. The computer interprets these messages, using a vocabulary stored in ROM, and responds appropriately; the GPIB adapter transmits the computer's outgoing messages to the bus. The data and control lines between the GPIB adapter and the 24-pin connector on the rear panel are buffered by IC3 and IC4. The device address inputs from the IEEE Adress PC board (A111) are buffered by IC1.

PERIPHERAL INTERFACE ADAPTER

The PIA (IC13) is a programmable port through which information is transmitted between the computer's data bus and other devices. Three of its outputs are decoded by IC12 into eight control lines. The PIA is used for various instrument control functions, including the programming of digital to analog converters.



U#	TYPE	PIN# +5	PIN# GND
1	74LS365	16	8
2	WD9914P	40	10
3	75162	11	1
4	75160	20	10
5	74LS17	14	7
6	74LS245	20	10
7,9	74244	20	10

U#	TYPE	PIN# +5	PIN# GND
8	A1	20	10
10	74LS32	14	7
11	74LS00N	14	7
12	74LS138	16	8
13	MC68B21	20	1

FIG: 7.A3.2
FAST IEEE PIA PC ASSY (A3)
DWG# 101BM06701 SHT 2

REV A

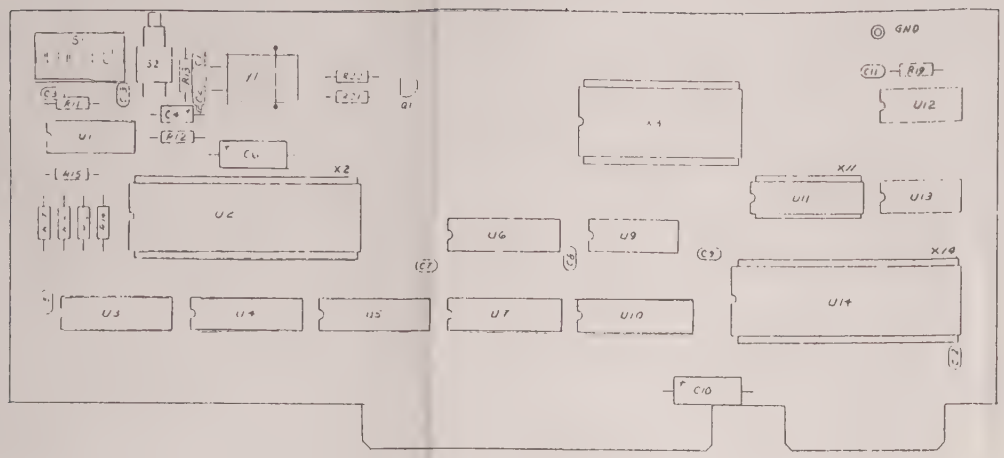


FIG: 7.A4.1
CPU PC ASSY (A4)
DWG# 101BM35801 SHT 1

REV B

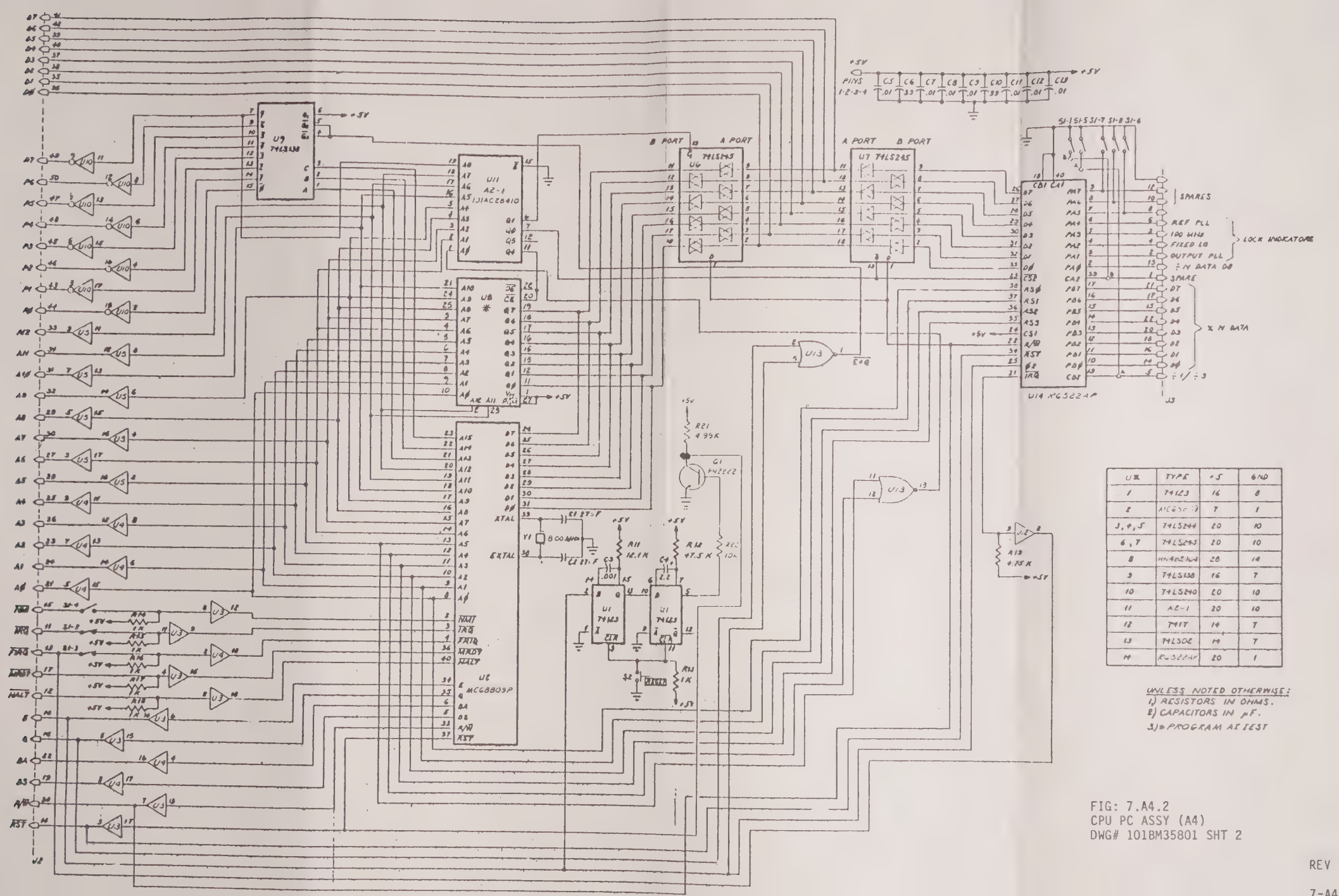
CPU -- Circuit Board A4

This portion of the computer houses the central processing unit, which is in the form of an MC6809 microprocessor (U2). Also present on the board are buffers, initialization memory and an input/output device.

The microprocessor has an 8-bit data bus and a 16-bit address bus; it has an internal clock oscillator regulated (at 3.579 MHz) by crystal Y1. The clock frequency was chosen to avoid the generation of beat frequencies between its harmonics and the various reference signals produced within the synthesizer (most of the latter are multiples of 1 MHz). Multivibrator U1 furnishes a reset "low" pulse to the microprocessor upon power-up or whenever S2 is pressed.

U8, a PROM having a capacity of 8K bytes, represents the instrument's initialization memory; it includes level characterization data and other information unique to the individual instrument in which it is installed. Output buffers U3, U4, U5, and U10 interconnect the microprocessor's address bus and control lines with the computer bus. Address decoding is aided by the 3-to-8 line decoder, U9, which converts the three high-order address lines to eight page-lines. The computer uses these page-lines to select peripheral devices on other circuit boards. Within this circuit board, device address decoding is performed by U11, a high speed bipolar PROM, whose decoded outputs drive the chip select lines and data direction select lines of the board's other IC's. The microprocessor's data bus is connected to the computer bus, and to input/output device U14, via bi-directional gates U6 and U7.

U14 is a programmable input/output device through which information is transmitted between the microprocessor data bus and other circuits. It is used for a number of instrument control and monitoring functions, such as programming the 10 dB step attenuator and polling the various PLL "lock" indicators.

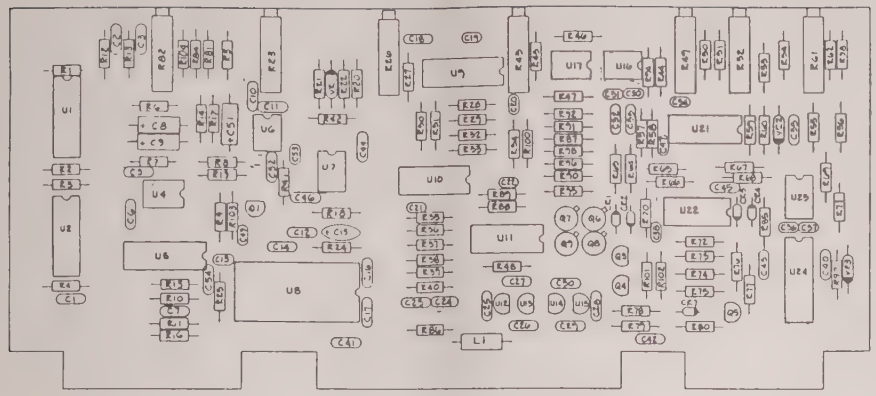


U#	TYPE	+5	GND
1	74LS23	16	8
2	MC6809P	7	1
3, 4, 5	74LS244	20	10
6, 7	74LS245	20	10
8	HM-6264LP-4	28	14
9	74LS138	16	7
10	74LS240	20	10
11	A2-1	20	10
12	7417	14	7
13	74LS08	14	7
14	R6522AP	20	1

UNLESS NOTED OTHERWISE:
1) RESISTORS IN OHMS.
2) CAPACITORS IN μF.
3) * PROGRAM AS TEST

FIG: 7.A4.2
CPU PC ASSY (A4)
DWG# 101BM35801 SHT 2

REV B



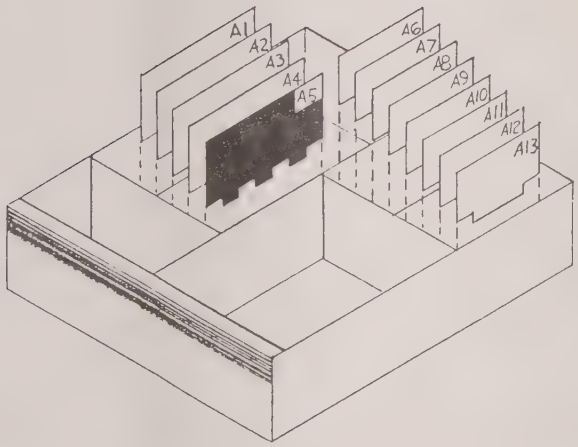


FIG: 7.A5.1
LEVEL CONTROL PC ASSY (A5)
DWG# 304BM03500 SHT 1

REV K

LEVEL CONTROL -- Circuit Board A5

This board houses the circuits which control the leveler and step attenuator, and also includes the circuit which drives the internal modulation meter display.

AUTOMATIC LEVEL CONTROL (ALC)

The ALC circuit drives the leveler, a variable attenuator circuit in the RF module, in order to make fine adjustments of output power. Feedback from a level detector in the RF path is compared with a leveling reference, and the the leveler is driven so as to equalize these two inputs.

The leveling reference is set by the computer through programming of the digital to analog converter, U24. At U22-6, the reference is combined with a correction voltage from the temperature compensation circuit (A112). During operation in the AM mode, these inputs to U22-6 are also combined with a modulation signal. The AM input is processed by logarithmic amplifier U9 (to match it to the log characteristic of the level reference and temperature compensation inputs) and furnished through FET Q9 to the summing junction at U22-6 (Q9 is turned off when AM is off). The combined leveling reference signal is processed by anti-logarithmic amplifier U21 and applied to the non-inverting input at U22-3, where it is combined with the amplified signal from the level detector (see U17, U16).

The signal at the inverting input U22-2 is amplified (U22-8) and furnished to the driver output circuit (Q3, Q4). This driver is a controlled current source for the PIN diode leveler circuit in the RF module. The polarity is positive for increased attenuation, negative for reduced attenuation. Following the leveler circuit in the RF path is a level coupler and diode detector (during operation in the external ALC mode, a remote coupler and detector are used). The detector returns a negative voltage proportional to detected RF power. The ALC circuit drives the leveler in such a way that the amplified detector signal and the leveling reference signal cancel for a zero voltage at U22-3.

When the detector and reference signals at U22-3 are in equilibrium, the amplifier output at U22-1 is zero; U22-14 turns off transistor Q5 and the 'leveled' indicator output is pulled high, illuminating the level LED on the 600's front panel. If the ALC circuit has not yet adjusted the RF output to the requested level, a significant voltage will be present at U22-1, turning Q5 on and pulling the indicator output low.

MODULATION METER

An integrated digital voltmeter circuit, U8, drives the modulation meter display on the front panel. It requires a DC voltage input (from U7-6) proportional to the amplitude of the modulation waveform. The AM and FM modulation waveforms are furnished (through analog gate U5) to U4, amplified, and applied to comparator U6. The other input to the comparator is fed back from the meter chip input at U7-6. By driving the transistor circuit (Q1, Q2), through level translator U3, the comparator builds up a charge on C2 until the DC input to the meter chip equals the peak voltage of the modulation signal.

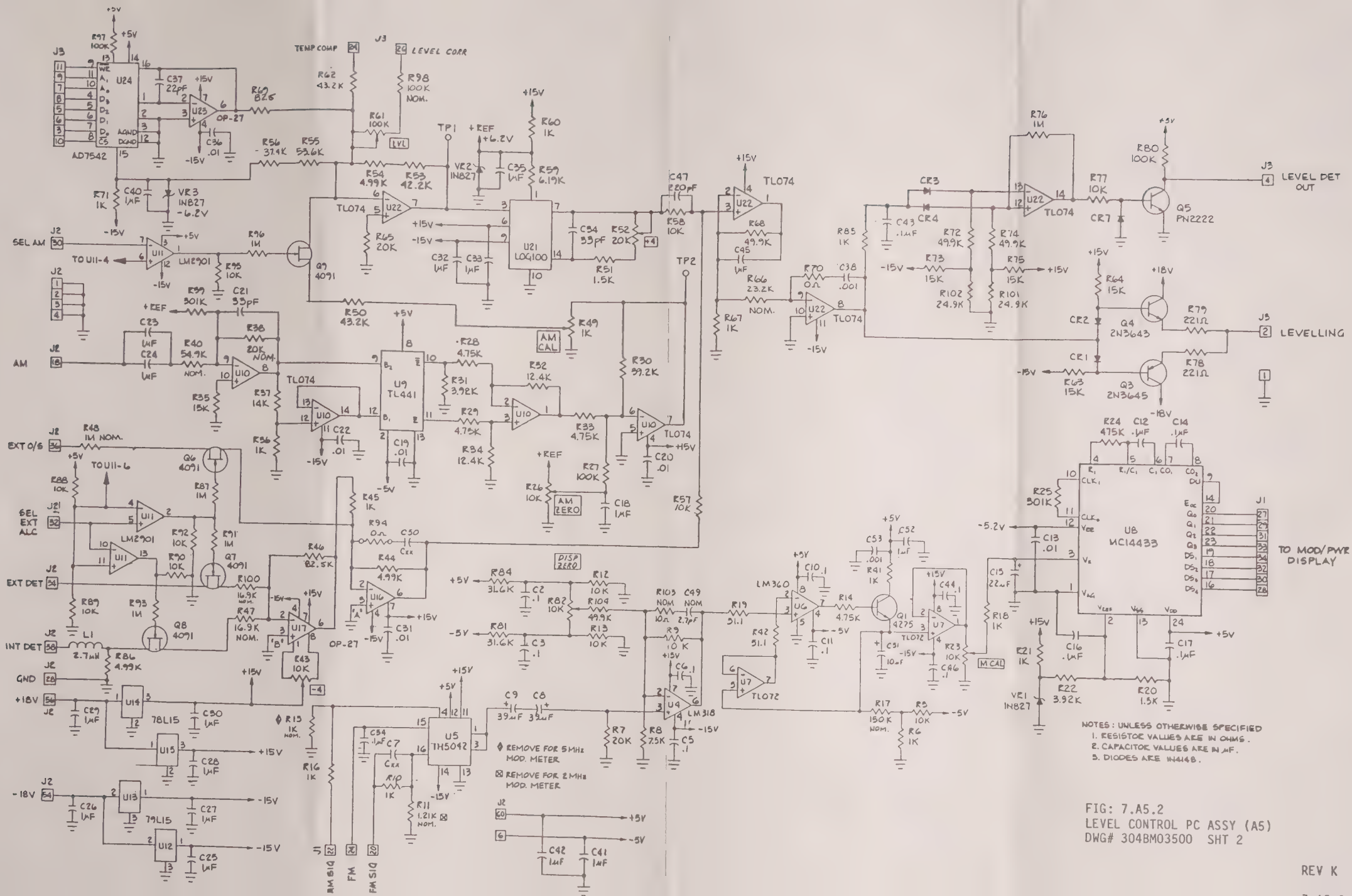


FIG: 7.A5.2
LEVEL CONTROL PC ASSY (A5)
DWG# 304BM03500 SHT 2

REV K

ATTENUATOR RELAY DRIVER

The 10 dB step attenuator is programmed by switching any or all of four fixed-attenuation segments into or out of the device's RF path. The attenuation values of the individual segments are 40 dB, 40 dB, 20 dB and 10 dB. For a setting of 110 dB, all segments are activated. The mechanical switching is enabled by relay drivers U1 and U2, which respond to TTL-level inputs and provide output levels of zero and approximately +24 volts (the unregulated supply voltage). By programming the drivers, the computer can select attenuation values between zero and 110 dB, in steps of 10 dB.

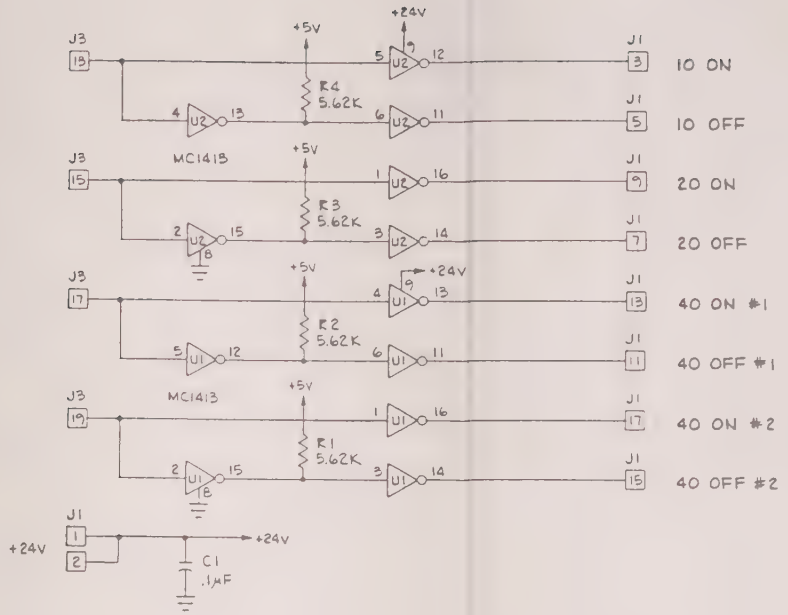


FIG: 7.A5.3
LEVEL CONTROL PC ASSY (A5)
DWG# 304BM03500 SHT 3

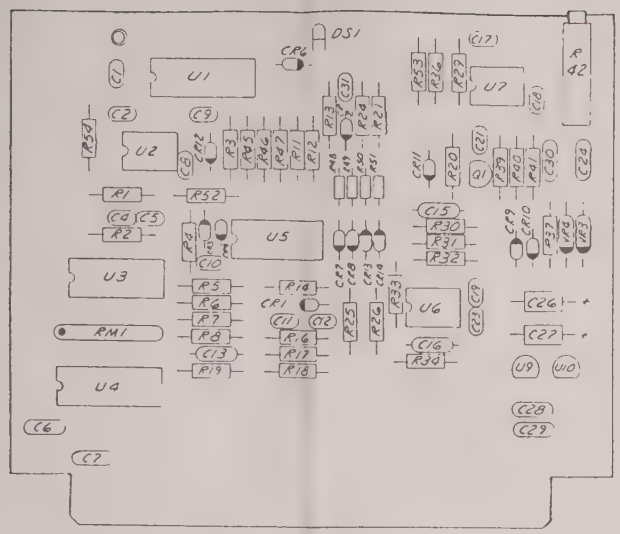


FIG: 7.A6.1
OUTPUT PLL PC ASSY (A6)
DWG# 304BM01001 SHT 1

REV C

OUTPUT PLL -- Circuit Board A6

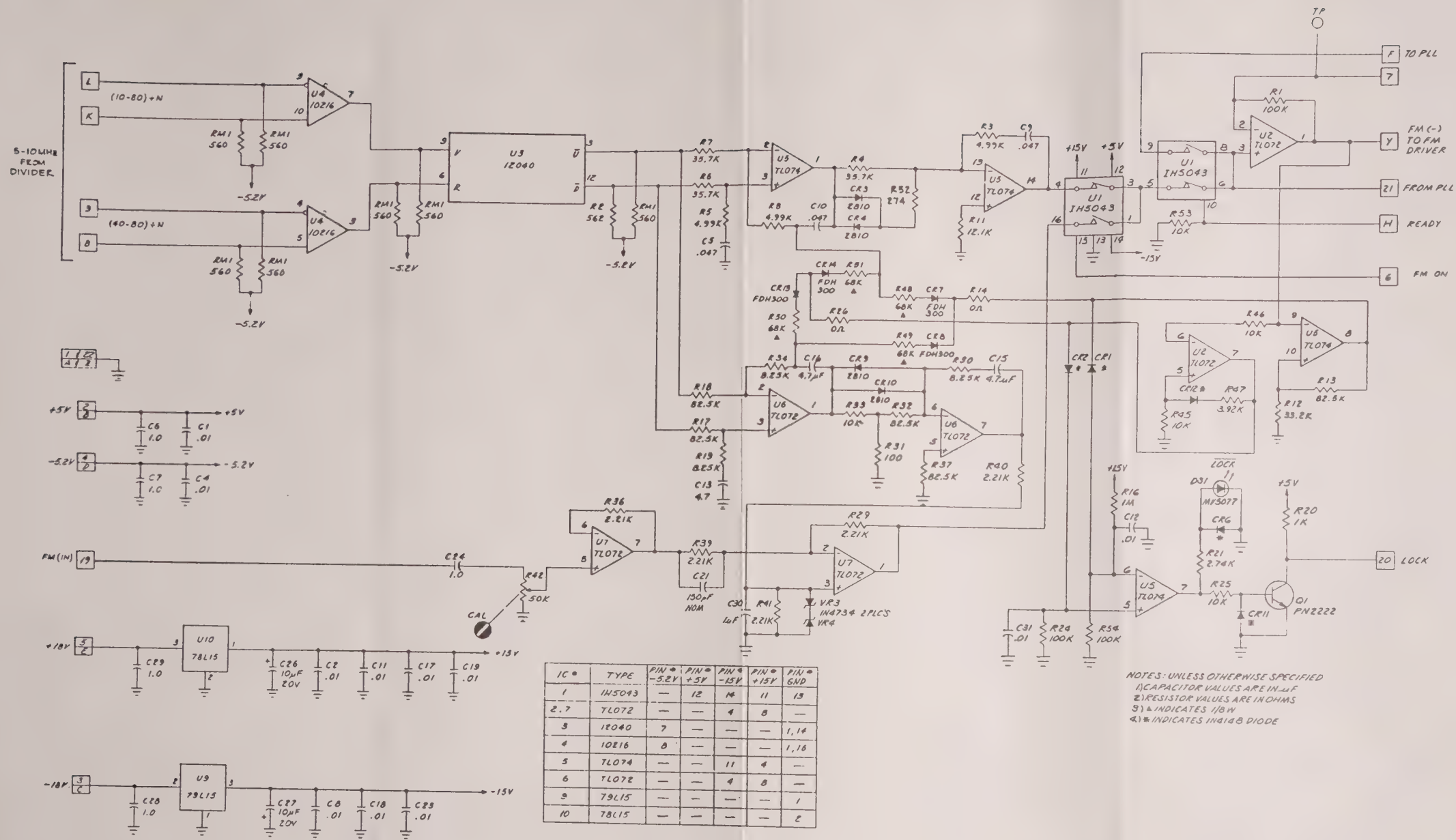
This circuit produces a control signal for use in fine-tuning the instrument's YIG oscillator, in order to phase lock the YIG frequency to the master reference. In the FM mode, the control signal is combined with a modulation input.

The phase detector (U3) receives two input frequencies, both of which are in the 5-10 MHz range; when the loop is locked these frequencies are equal. The reference frequency input (fR) comes from the divide by 8 circuit on the divider board (A7), and the variable frequency input (fV) comes from the divide by N circuit on the same board. The phase detector produces outputs at pins 3 and 12 of U3; if the input frequencies are not in phase, wide pulses appear at one of these pins, depending on whether fV is leading or lagging. The outputs are used by the lock detector circuit (see U5-7, Q1) to determine whether the loop is locked. They are also used by one of two independent loop amplifier circuits (selected by analog gate U1) to produce the loop's control output.

The first loop amplifier circuit is used when the instrument is not in FM mode. The phase detector outputs are amplified by U5-1 and U5-14; frequency compensation networks (R8/C10, R5/C5, R3/C9) provide the rolloff needed to stabilize the loop. Diodes in the feedback loops of the amplifiers limit the amplifier outputs in order to prevent saturation during search. The output of U5-14 is applied (through the analog gate, U1) to the output amplifier, U2-1. This output is used by the FM driver (see A103) to tune the YIG oscillator's FM coil; it goes more negative to increase frequency and more positive to decrease.

The second loop amplifier circuit is used when the instrument is in the FM mode. Essentially, it duplicates the first loop amplifier (see U6-1, U6-7) but adds the input FM signal (amplified by U8-7) to the phase detector output signal. The two signals are combined by U7-1 and applied to analog gate U1.

The variable frequency input to the phase detector is derived from the sampling mixer's IF, not directly from the YIG output frequency. The sampler's IF is the product of a harmonic multiplier, and may be derived from the wrong harmonic. In that case the phase lock loop is misdirected, tuning the YIG oscillator in the wrong direction until it reaches its "+" or "-" rail. To prevent the PLL circuit from becoming stuck in this mode, a search circuit is added. This consists of amplifiers U5-8 and U2-7, which monitor the circuit output and return control voltages to the loop amplifier circuits. When the output becomes too positive (minimum frequency), U5-8 swings to its negative rail, driving the output negative (maximum frequency). When the situation is reversed, U2-7 drives the output positive (minimum frequency).

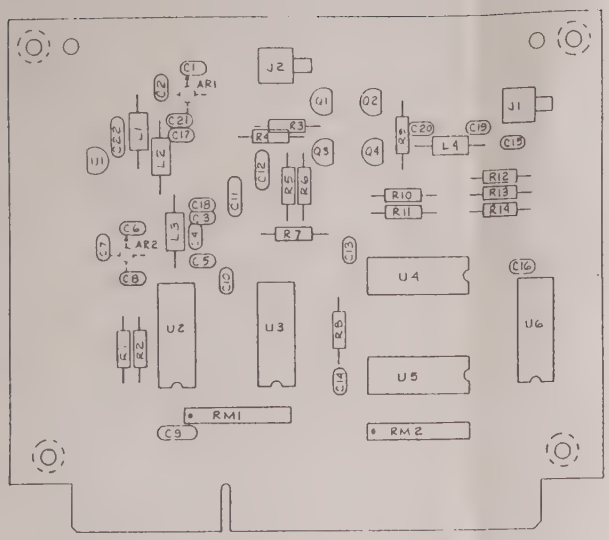


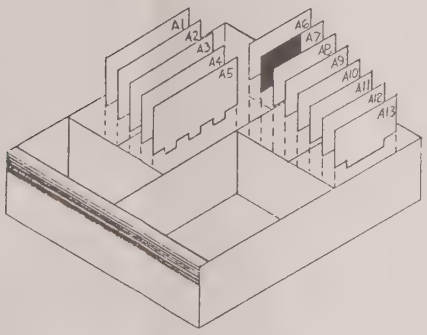
IC #	TYPE	PIN # -5.2V	PIN # +5V	PIN # -15V	PIN # +15V	PIN # GND
1	IH5043	—	12	14	11	13
2,7	TL072	—	—	4	8	—
3	12040	7	—	—	—	1,14
4	10216	8	—	—	—	1,16
5	TL074	—	—	11	4	—
6	TL072	—	—	4	8	—
9	79L15	—	—	—	—	1
10	78L15	—	—	—	—	2

NOTES: UNLESS OTHERWISE SPECIFIED
1) CAPACITOR VALUES ARE IN μF
2) RESISTOR VALUES ARE IN OHMS
3) ▲ INDICATES 1/8 W
4) * INDICATES 1N4148 DIODE

FIG: 7.A6.2
OUTPUT PLL PC ASSY (A6)
DWG# 304BM01001 SHT 2

REV C





7.A7.1
DIVIDER PC ASSY (A7)
DWG# 304BM03100 SHT 1

REV D

DIVIDER -- PC Assy A7

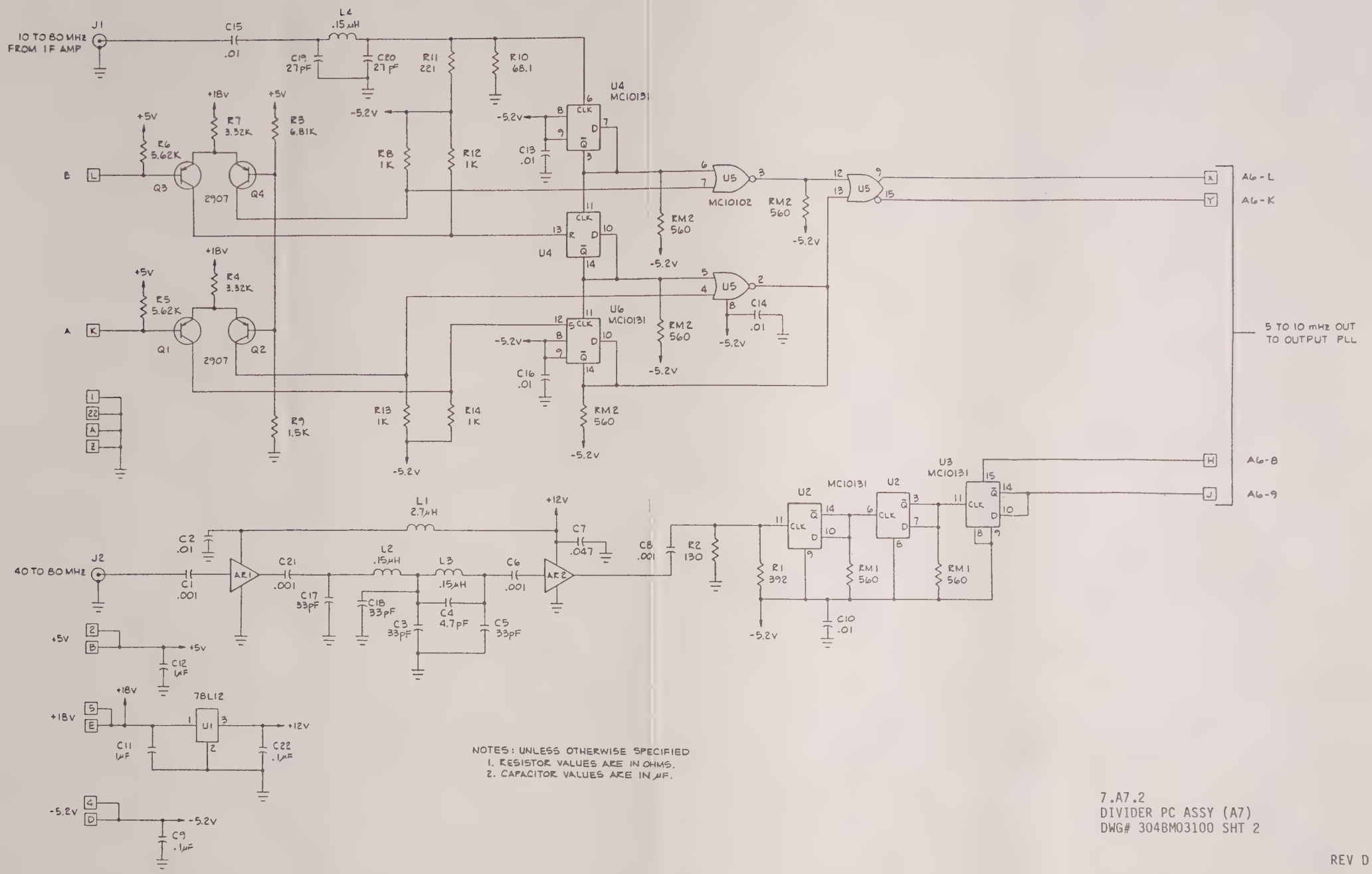
This circuit includes two frequency dividers, one fixed and one programmable, which supply paired 5-10 MHz signals to the output PLL circuit (A6).

The fixed frequency divider has a divisor of 8. It accepts an input frequency from the 40-80 MHz PLL circuit (A8). The input frequency is applied to a low-pass filter (L2/L3, etc.), and to amplifiers AR1 and AR2. The amplified 40-80 MHz signal is used to clock a series of three flip flops (U2, U3). The output of the third flip flop is the input frequency divided by 8 (in other words, it has a range of 5-10 MHz).

The programmable divider circuit can be set to divide by 2, 4, or 8. It accepts a 10-80 MHz sampler IF from the 300 MHz Oscillator board (A104). A low pass filter (L4, etc.) removes spurious high frequencies from the signal. A series of three flip flops (U4, U6) is used to provide three outputs equal to the input frequency divided by 2 (at U4-3), by 4 (at U4-14), and by 8 (at U6-14). The computer selects the appropriate divisor by means of the 'A' and 'B' control inputs. Because these inputs are at TTL logic levels, two differential amplifiers (Q1/Q2, and Q3/Q4) are used to convert them to ECL voltages. The differential outputs drive the SET and RESET inputs at U4-13 and U6-12, and also to drive the steering gates at U5-7 and U5-4. Only one of the three flip flops is allowed to contribute its output to the final buffer, U5-9.

The computer selects a divisor which will reduce the 10-80 MHz IF input to a 5-10 MHz output. The 'A' and 'B' control bits (see Q1 and Q3) are interpreted as follows:

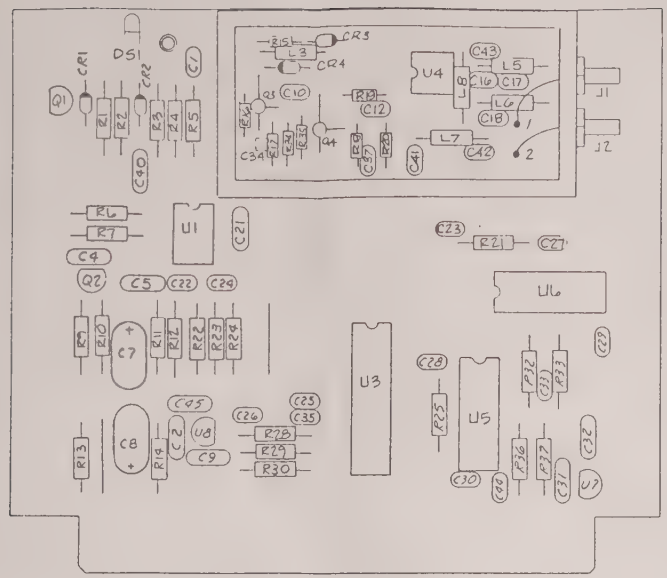
'A'	'B'	DIVISOR
0	0	2
0	1	4
1	1	8

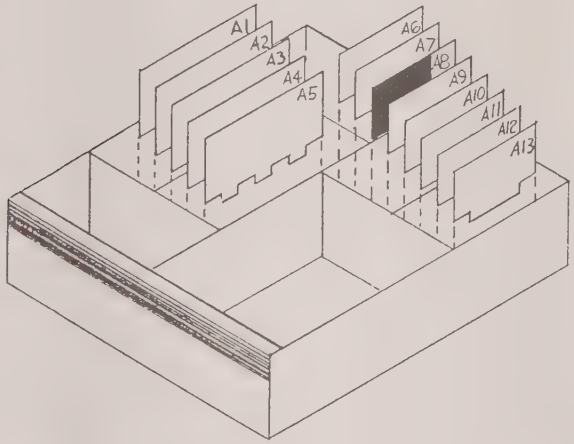


NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTOR VALUES ARE IN OHMS.
2. CAPACITOR VALUES ARE IN µF.

7.A7.2
DIVIDER PC ASSY (A7)
DWG# 304BM03100 SHT 2

REV D





7.A8.1
40-80 MHZ PLL PC ASSY (A8)
DWG# 304BM03000 SHT 1

REV I

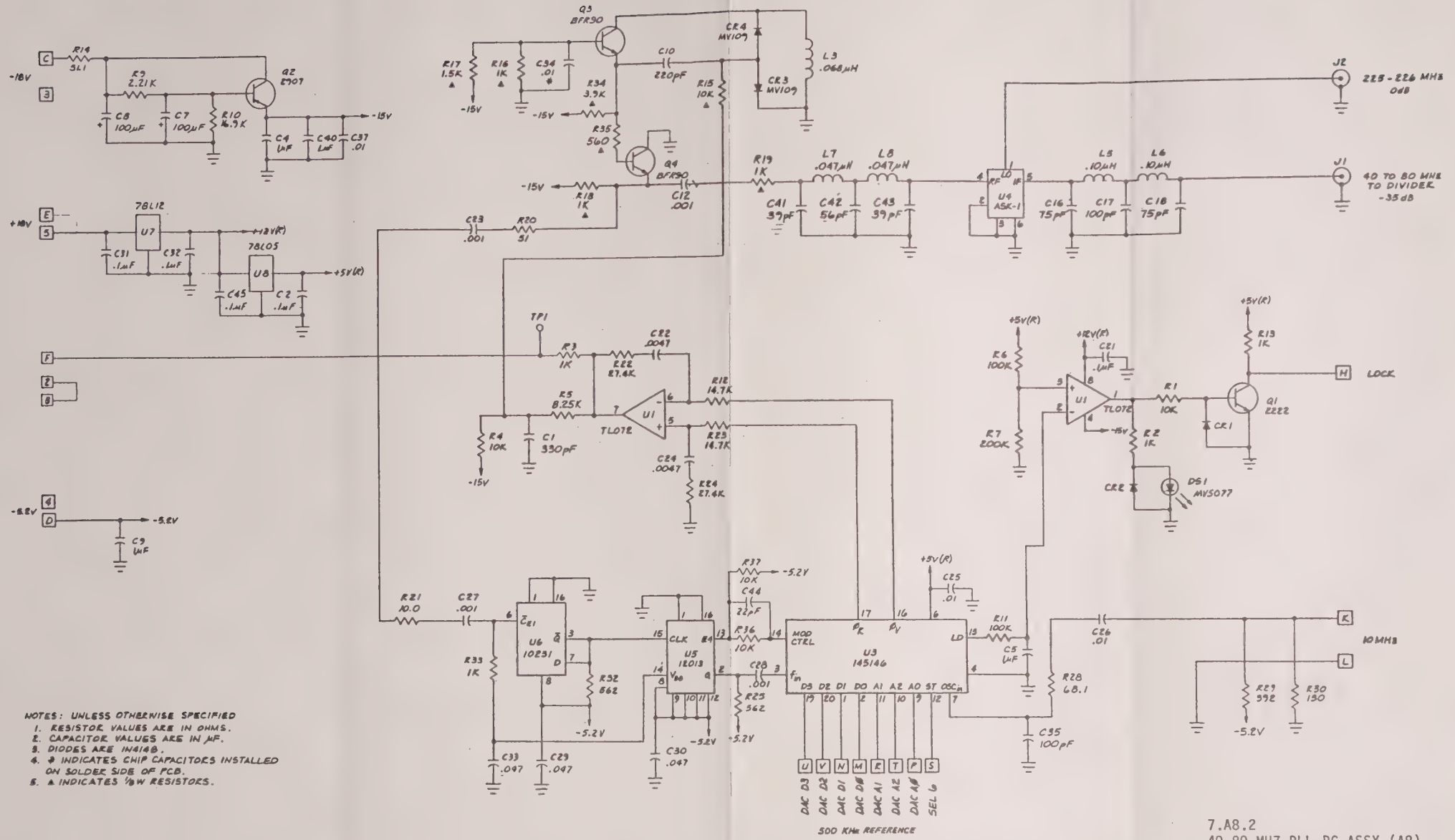
40-80 MHz PLL -- Circuit Board A8

This circuit provides a programmable reference frequency to the instrument's output phase lock loop. The 40-80 MHz circuit output at J1 is an intermediate frequency produced by mixer U4; it is equal to the difference between the 225-226 MHz input (J2) and the frequency produced by the VCO (Q3). A low pass filter (L5, etc.) removes spurious high frequencies from the IF output. The VCO has a range of 145-185 MHz, and is tuned by a phase lock loop circuit.

The PLL circuit is programmed by means of the MC145146 PLL chip, U3. This IC includes three programmable frequency counters: one for dividing the 10 MHz reference input, one for dividing the variable input (feedback from the VCO), and one for controlling an external prescaler (U6/U5) on the variable input. The IC's reference input (U3-7) is taken from the 10 MHz master reference input. The reference counter is programmed to divide the 10 MHz input by 40, for a 250 kHz input to the internal phase detector. The variable counter and the external prescaler counter (U6/U5) are used in combination to divide the VCO frequency, for a 250 kHz input to the internal phase detector when the loop is locked.

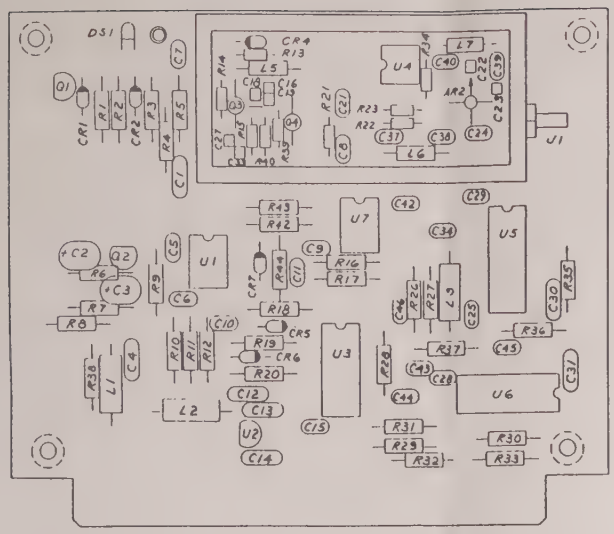
The phase detector outputs at U3-17 and U3-16 provide output pulses to indicate whether the variable frequency (derived from the VCO output) is leading or lagging the reference. These pulses are converted by loop amplifier U1-7 into a tuning voltage for the VCO. By programming U3's internal counters, the computer can select a VCO frequency in 1 MHz steps between 145 and 185 MHz.

U3's internal lock detector (pin 13) drives U1-1 and Q1 so that the DS1 is illuminated and the 'lock' output at pin H is low for the unlocked condition. In the locked condition, DS1 is dark and pin H is high.



7.A8.2
40-80 MHZ PLL PC ASSY (A8)
DWG# 304BM03000 SHT 2

REV I



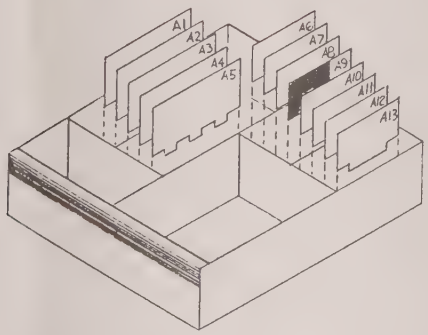


FIG: 7.A9.1
INTERMEDIATE PLL -- PC ASSY A9
DWG# 304BM02700

REV G

INTERMEDIATE PHASE LOCK LOOP -- PC board A9 (Option 03 only)

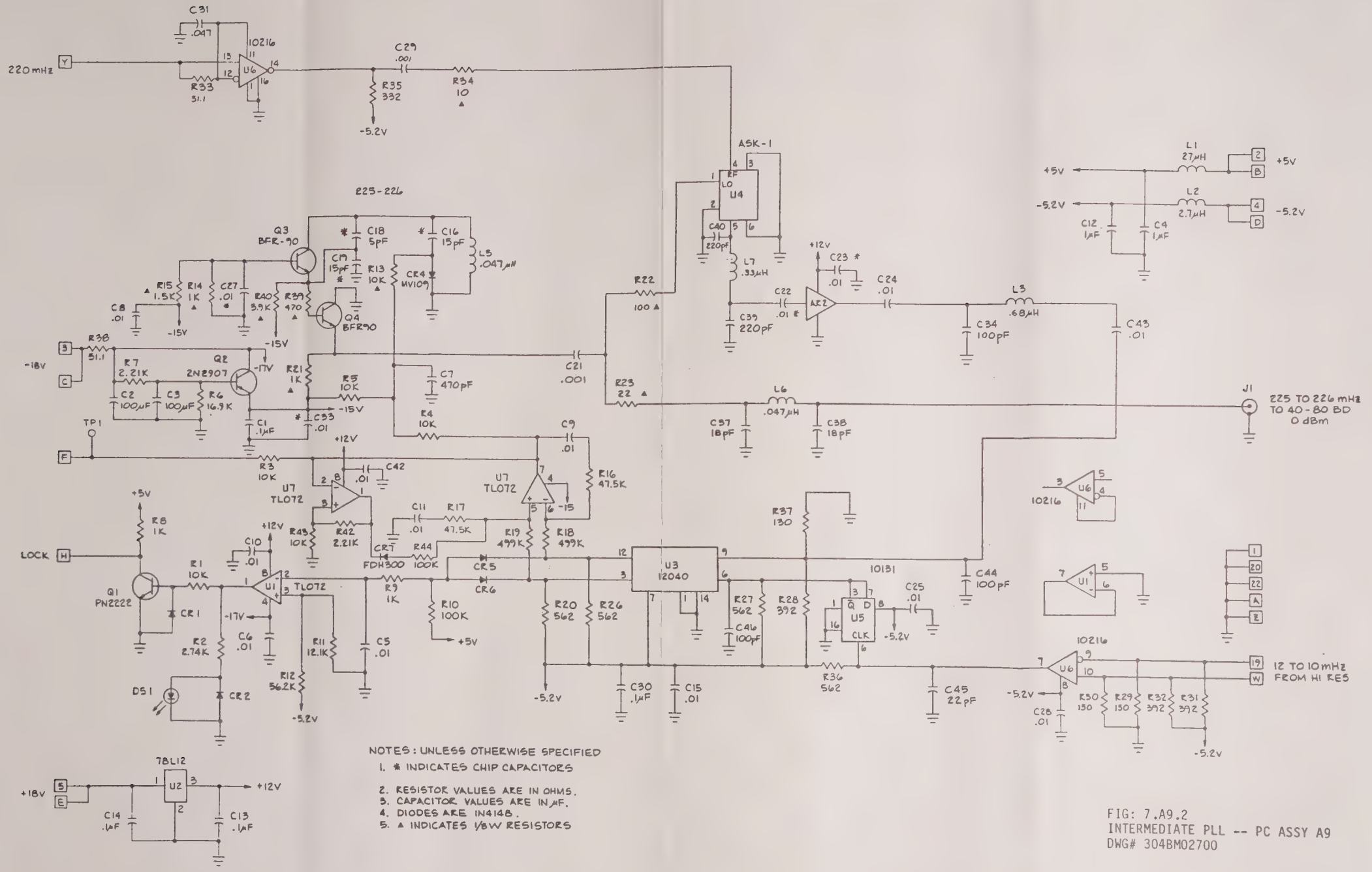
The function of this circuit is to synthesize frequencies between 225 and 226 MHz (for use by the 40-80 MHz PLL), derived from reference inputs at 220 MHz and 10-12 MHz. The main elements of the circuit are the voltage controlled oscillator (VCO), the mixer, the phase comparator, and the lock detector.

The VCO (see Q3, etc.) is designed to oscillate at 225 to 226 MHz; its output frequency is determined by the tuning voltage received from U7-7 (the tuning voltage is measurable at TP1). The VCO output is furnished (through a low pass filter which eliminates harmonics) to connector J1. The VCO is also applied to the RF mixer (see U4).

The RF mixer combines the VCO frequency with the 220 MHz reference input frequency (buffered by U6-14), producing at U4-5 an intermediate frequency (IF) output equal to the difference between them, or 5 to 6 MHz. Since the 220 MHz input is fixed, the IF is determined entirely by the VCO output. The IF output is amplified (AR2), filtered (see L3, etc.), and applied to the variable input of the phase comparator (U3-9).

The phase comparator produces pulses at one of its outputs pins (U3-3 or U3-12) depending on whether its variable input (pin 9) is leading or lagging the reference input (pin 6). The reference input is at 5-6 MHz and is derived from the 10-12 MHz input from the high resolution PLL board (pins W and 19, buffered by U6-7 and divided in half by flip flop U5). The loop amplifier (U7-7) converts U3's output pulses into a DC control voltage for the VCO. The phase comparator tunes the VCO upward or downward in order to equalize its two input frequencies; when these two frequencies are equal, the loop is "locked". The output frequency of the circuit as a whole (J1) is therefore determined by the frequency of the 10-12 MHz input.

The phase comparator's output pulses are furnished (via CR5, CR6) to the lock detector circuit (see U1-2). When the loop is unlocked (i.e., when there is a large difference between the phase comparator's inputs) the output pulses become very wide, U1-1 goes high, turns on Q1 and fault indicator DS1, and pulls the 'LOCK' output (pin H) low.

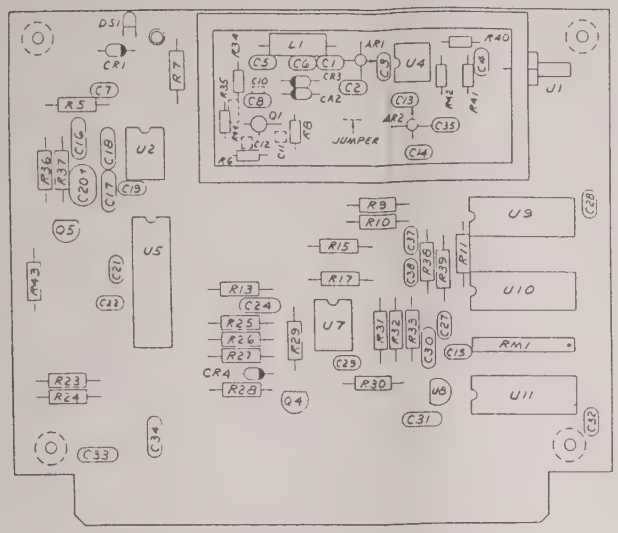


NOTES: UNLESS OTHERWISE SPECIFIED

1. * INDICATES CHIP CAPACITORS
2. RESISTOR VALUES ARE IN OHMS.
3. CAPACITOR VALUES ARE IN μF.
4. DIODES ARE IN4148.
5. ▲ INDICATES 1/8W RESISTORS

FIG: 7.A9.2
INTERMEDIATE PLL -- PC ASSY A9
DWG# 304BM02700

REV G



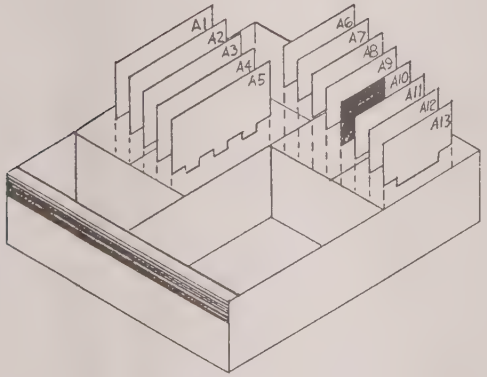


FIG: 7.A10.1
HI RESOLUTION PC ASSY (A10)
DWG# 304BM03400 SHT 1

REV F

HIGH RESOLUTION -- PC Assy A10 (Option 03 Only)

This circuit generates a reference frequency in the range of 10-12 MHz, programmable in steps of 2 kHz. A voltage controlled oscillator (Q1, etc.) produces a 250-300 MHz signal which, divided by 25 (U9, U10) yields the circuit's output frequency. A programmable synthesizer circuit tunes the VCO in order to generate a range of frequencies which are phase locked to the 10 MHz master reference. Because the VCO frequency is much higher than the master reference, it is mixed (U4) with the 220 MHz reference input to create a 30-80 MHz IF which is within the frequency range of the PLL circuit.

Synthesizer chip U5 contains three programmable counters and a phase detector. One internal counter divides the 10 MHz master reference by 200, yielding a 50 kHz reference for the phase detector. The remaining internal dividers are used in conjunction with the external prescaler divider (U2, which divides by either 15 or 16) in order to reduce the 30-80 MHz mixer IF to 50 kHz. In addition, it utilizes an external prescaler counter (U2). One of its phase detector outputs (pins 16 or 17) will produce wide pulses to indicate that the divided IF from the mixer is leading or lagging the divided master reference. The loop amplifier (U7-7) turns the phase detector output pulses into a control voltage by which the VCO is tuned. The amplifier drives the oscillator in whichever direction will reduce the phase difference between the two phase detector inputs, until the VCO is phase locked to the master reference. U5's lock detector output (pin 13) is applied to the detector circuit (U7-1, Q4 etc.); the light emitting diode (DS1) is illuminated for the unlocked condition.

A sample of the VCO frequency is mixed (by U4) with the 220 MHz reference input from A113; the resulting 30-80 MHz IF is amplified (AR1), filtered (L1 etc.) and applied to prescaler U2.

The output frequency of the VCO is tapped at L2, which is implemented as a printed trace on the circuit board. AR2 amplifies the VCO signal. The circuit consisting of U9 and U10 is a fixed frequency divider with a divisor of 25. U9 divides by either 8 or 9 (its divisor is programmed by the logic level fed back from U10-3). The two flip flops of U10 are used as a divide-by-3; U10-3 is low during one cycle out of three, programming U9 to divide by 9 for that period and by 8 the rest of the time, for a total division of the VCO frequency by 25. The 10-12 MHz quotient is buffered and complemented by U11.

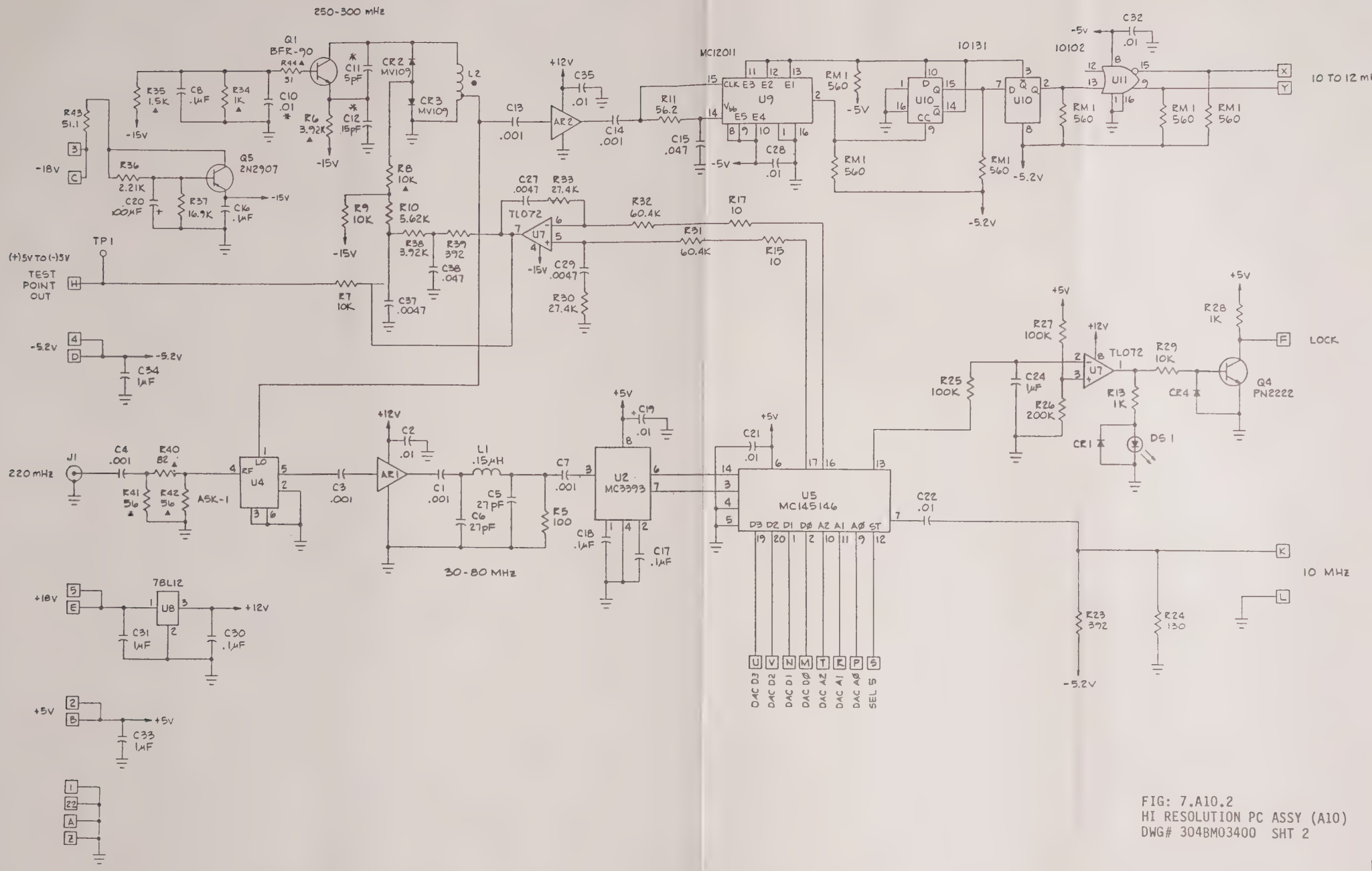
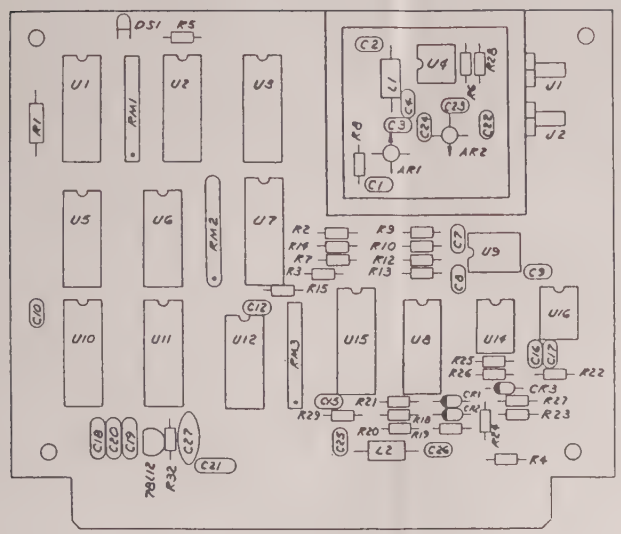
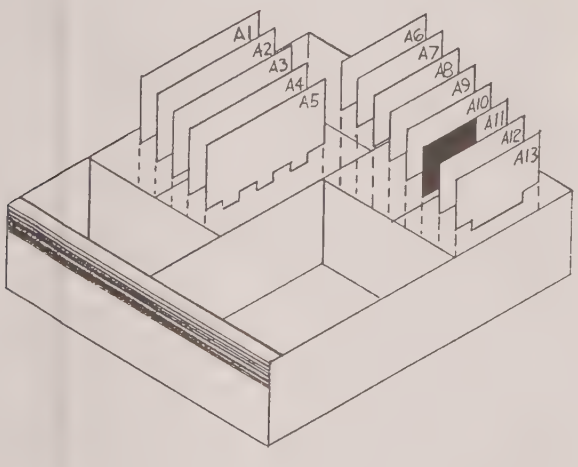


FIG: 7.A10.2
HI RESOLUTION PC ASSY (A10)
DWG# 304BM03400 SHT 2

REV F





7.A11.1
300 MHz PLL PC ASSY (A11)
DWG# 304BM02200 SHT 1

REV I

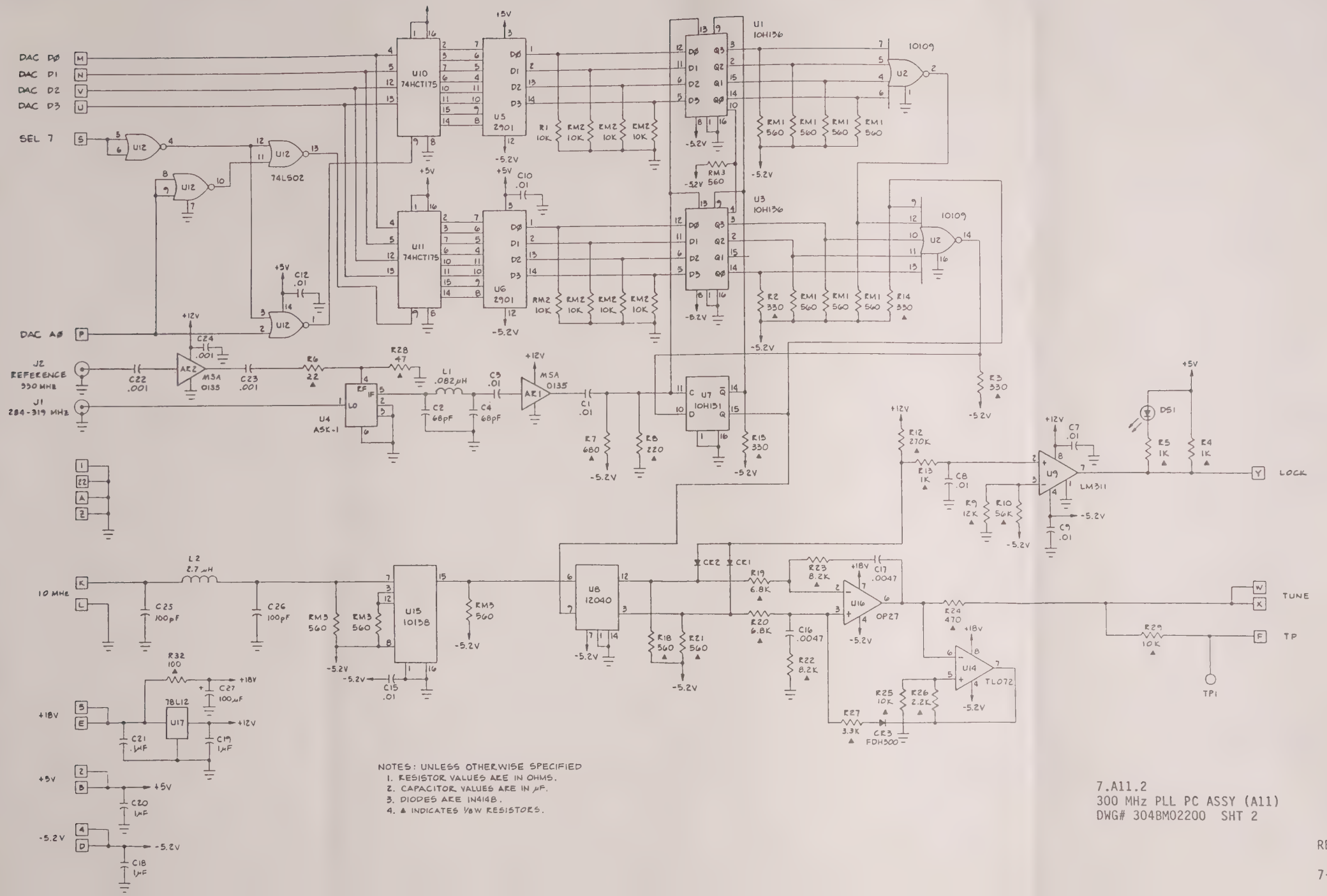
300 MHz PHASE LOCK LOOP -- Circuit Board A11

This circuit tunes the 300 MHz voltage controlled oscillator (PC board A104). The VCO can be programmed over a range of 284 to 319 MHz; the PLL circuit enables the computer to select the desired VCO frequency and phase lock the VCO to the instrument's 10 MHz timebase. The input at J1 is feedback from the VCO. Because the 284-319 MHz input frequency is too high to be counted by the digital circuits used here, the input signal is mixed (see U4) with the 330 MHz reference input (received at J2 and amplified by AR2) yielding an intermediate frequency in the range of 11-46 MHz. A low pass filter (L1 etc.) removes the mixer input frequencies. The IF is then amplified (AR1) and applied to the programmable divider.

The purpose of the programmable divider is to divide the 11-46 MHz IF down to 1 MHz. The first stage of the divider consists of latches U10 and U11; the computer selects the divisor (in the range of 11-46) by loading it as two successive four-bit words into these latches (U12 drives the chip select lines of the latches). The complementary outputs of the latches are applied to the comparators of U5 and U6; the comparator outputs translate the eight-bit divisor into ECL levels for use by the high speed ECL down-counters, U1 and U3. The counters are clocked by the amplified IF, and count down from the numbers programmed into them. U3 represents the four least significant bits, U1 the four most significant bits. Flip flop U7, also clocked by the IF, receives a high at its 'D' input (U7-10) at the end of the count and sends a high output pulse (from U7-15) to the phase comparator. The counters are reset by U7-14 and the count repeats.

The phase comparator chip, U8, requires reference and variable frequency inputs. The reference input is derived from the instrument's 10 MHz timebase. The 10 MHz input is received at pins K and L, filtered (L2 etc.) and divided by ten at U15. The 1 MHz quotient is applied to the comparator at U8-6. The variable input, received from the programmable divider circuit (see U7-15), is applied to the comparator at U8-9. The phase comparator produces wide pulses at one of its outputs (pin 3 or 12) depending on whether the variable input is leading or lagging the reference. The loop amplifier circuit (U16 etc.) converts these pulses into a DC voltage output (pins W, X) with which to tune the VCO. The polarity of tuning is: more positive to increase frequency, more negative to decrease frequency. The PLL circuit tunes the VCO in whatever direction will reduce the phase difference between the reference and variable inputs to the comparator. Filter components in the loop amplifier circuit (C16, C17, etc.) remove the phase comparator's output pulses from the tuning signal.

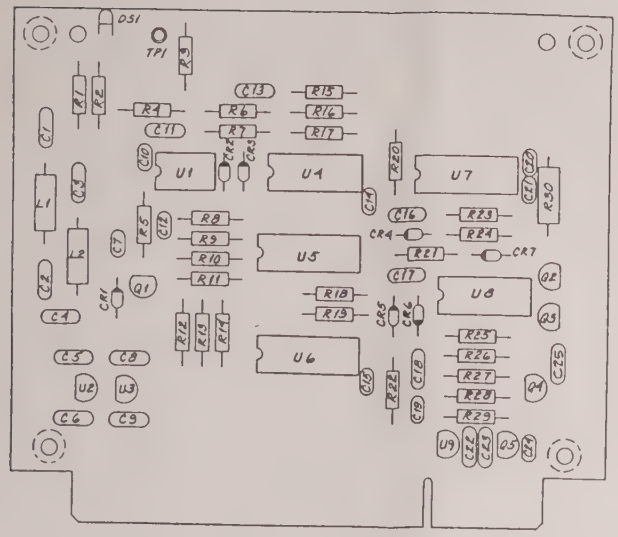
When there is a large phase difference between the reference and variable inputs to the comparator (i.e., when the loop is "unlocked"), wide low-going pulses appear at one of U8's outputs. These pulses are detected by the circuit consisting of U9 etc., and cause the 'LOCK' output at pin Y to go low and the LED (DS1) to be lit. When the loop is locked, U8's output pulses become extremely narrow and shallow, the 'LOCK' output is high, and the LED is extinguished.

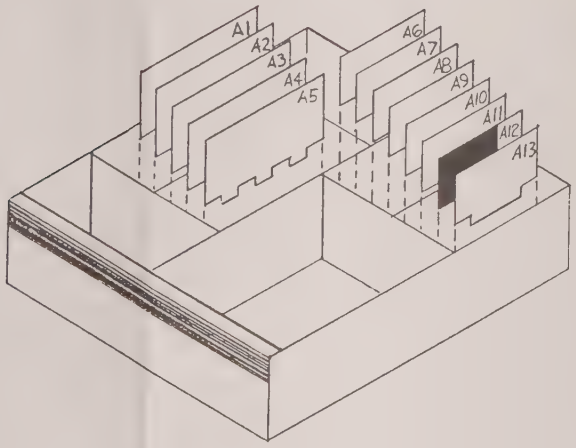


NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTOR VALUES ARE IN OHMS.
2. CAPACITOR VALUES ARE IN μF.
3. DIODES ARE IN4148.
4. ▲ INDICATES ¼W RESISTORS.

7.A11.2
300 MHz PLL PC ASSY (A11)
DWG# 304BM02200 SHT 2

REV I





7.A12.1
110 MHz PLL PC ASSY (A12)
DWG# 304BM05600 SHT 1

REV E

110 MHz PHASE LOCK LOOP -- PC Board A12

The function of this circuit is to phase lock the 110 MHz VCO on the oscillator/multiplier board (A113) to the 10 MHz master reference. In addition, this circuit performs important functions related to the master reference itself.

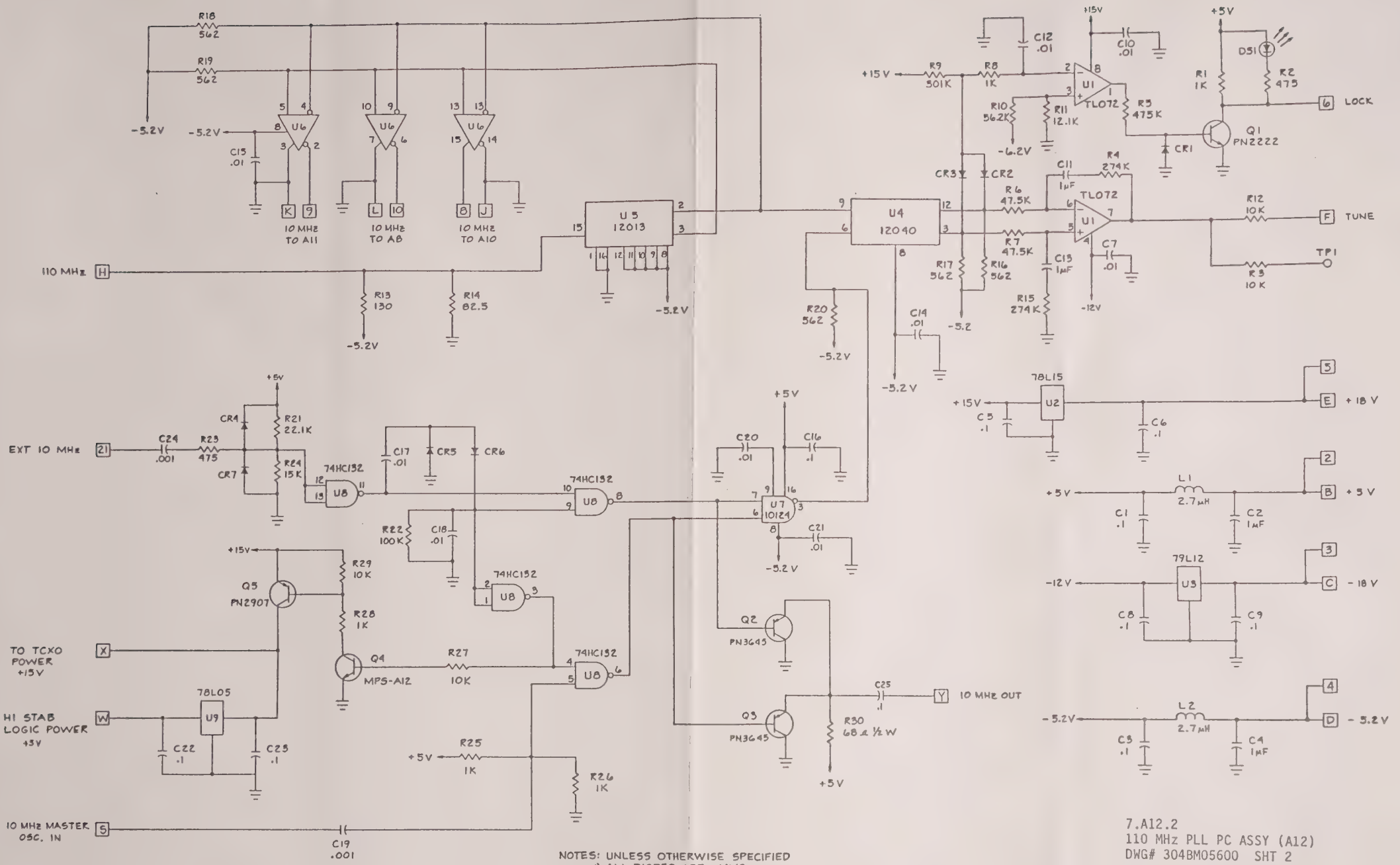
The output frequency of the 110 MHz VCO is received at pin H; U5 divides this input by 11. When the loop is locked, the input is exactly 110 MHz, and the divider's output is exactly 10 MHz. This output is applied to the variable input of the phase comparator at U4-9. The reference input to the phase comparator comes from the 10 MHz input/output circuit.

Model 600 is designed to accept an external 10 MHz timebase input, and this external input, whenever present, is automatically substituted for the internal timebase. The external 10 MHz signal is received at pin 21; the input is AC coupled (C24); U8-11 is triggered by an input of 1 Vpp or greater. When an external input is present, the signal propagates through U8-8 and TTL-ECL translator U7-3 to the reference input of the phase detector at U4-6. The external signal is also used to charge C18, so that U8-3 is held low. This low level turns off Q4 and Q5, cutting off the +15V and +5V power supplies to the internal timebase oscillator, so that it will not interfere with the active timebase. The timebase signal also propagates through Q2 to the instrument's timebase output, via pin Y.

When no external 10 MHz input is present, U8-3 is held high; Q4 and Q5 are turned on and the supply voltages are furnished to the internal timebase oscillator. The input from the internal timebase, received at pin S, propagates through U8-6 and U7-3 to the phase detector. The timebase signal also propagates through Q3 to the instrument's timebase output, via pin Y.

When its reference and variable inputs are not in phase, U4 produces wide pulses at one of its outputs, depending on whether the variable input is leading or lagging the reference. The pulsed outputs are filtered and amplified by U1-7 to produce a voltage output (pin F) which tunes the 110 MHz VCO.

The lock indicator circuit (U1-1, Q1) responds to the wide pulses which occur on the phase detector outputs when the loop is unlocked by turning on Q1, pulling the output low, and illuminating DS1. When the loop is locked, Q1 is off and DS1 is dark.



NOTES: UNLESS OTHERWISE SPECIFIED
1) ALL DIODES ARE IN4148
2) CAPS ARE IN µF
3) RESISTORS ARE IN OHMS

7.A12.2
110 MHz PLL PC ASSY (A12)
DWG# 304BM05600 SHT 2

REV E

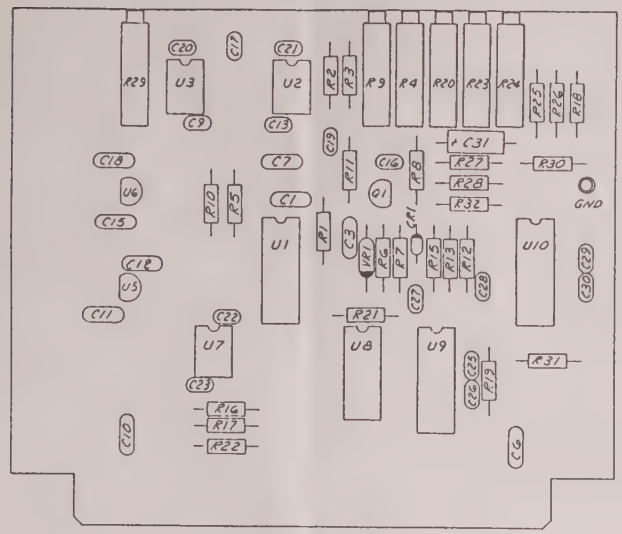


FIG: 7.A13.1
YIG DRIVER PC ASSY (A13)
DWG# 304BM02401 SHT 1

REV E

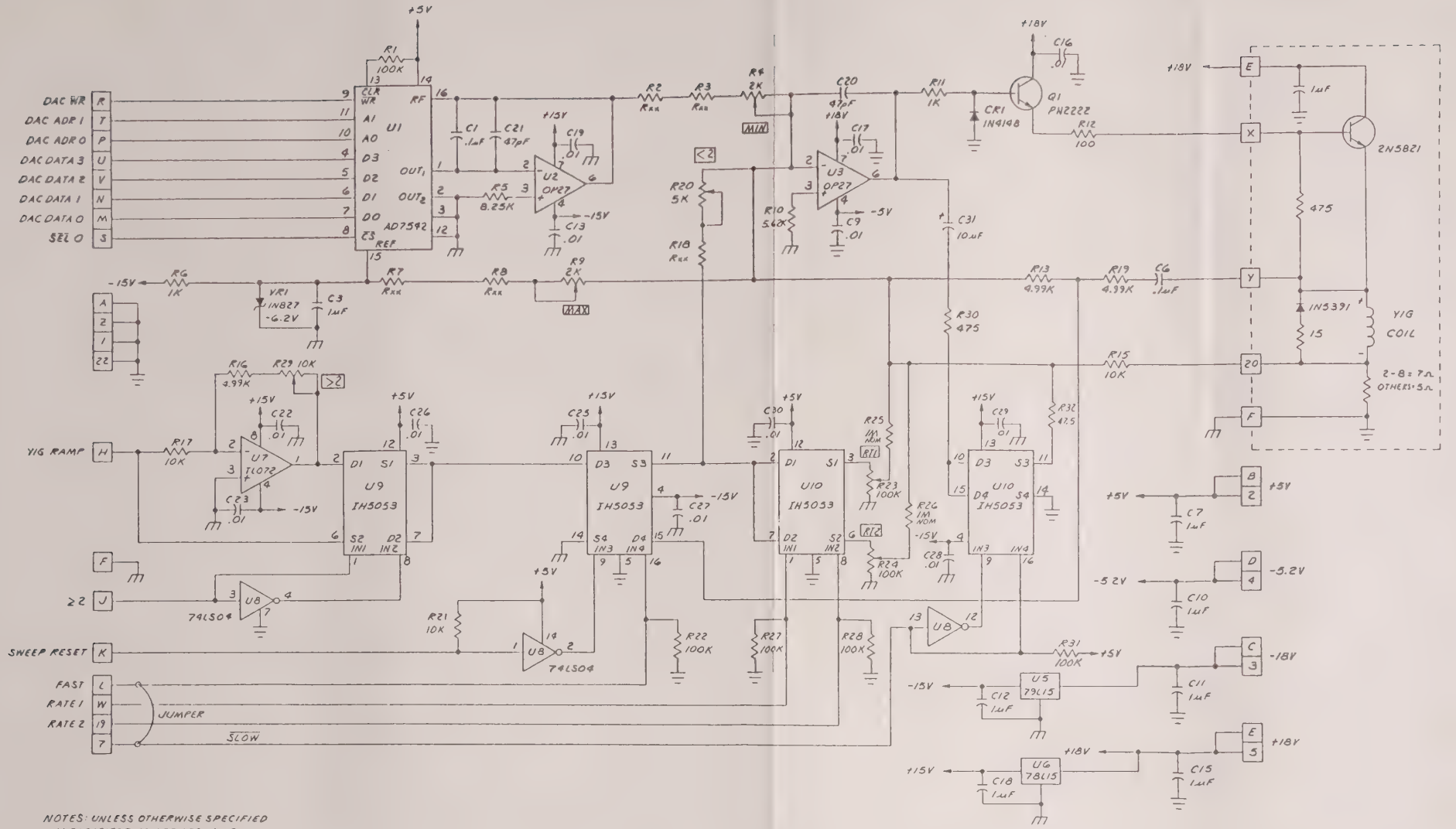
YIG DRIVER -- Circuit Board A13

This circuit is used to coarse-tune the output frequency of the instrument's YIG oscillator. The YIG frequency is determined by the current through its tuning coil; the sensitivity is 20 MHz/mA. Because the coil's impedance varies with temperature, it must be driven by a current source in order to maintain accuracy. The current source includes the +18 volt supply, the power transistor (2N5821), and the four-terminal sense resistor, all of which are located off of this circuit board; the YIG driver supplies a control signal to the base of the power transistor and receives feedback from the tuning coil.

U1 is a digital to analog converter; its analog output is proportional to the product of the digital number with which it is programmed by the system computer and the reference voltage applied to pin 15 (-6.2V). The DAC, together with inverting amplifier U2-6, produces a computer controlled voltage in the approximate range of 0 to +6 volts, with the voltage decreasing as frequency increases. Through resistors and a calibration pot, this voltage is applied to the summing junction at the inverting input of amplifier U3-6. There are two other inputs to this junction: a negative voltage from reference diode VR1 (by way of resistors and a second calibration pot), and a positive voltage fed back from the YIG oscillator tuning coil.

When the computer decreases the DAC voltage (in response to the operator's request for a higher frequency), a higher feedback voltage is required from the tuning coil in order to compensate for the change and maintain virtual ground at the summing junction. The output at U3-6 is driven more positive, increasing the current through Q1 and therefore increasing current through the power transistor, the tuning coil and the sense resistor. The positive voltage fed back from the tuning coil increases until the summing junction is restored to virtual ground, and the YIG settles on the new, higher frequency. In this way, the YIG frequency can be selected through the programming of the DAC.

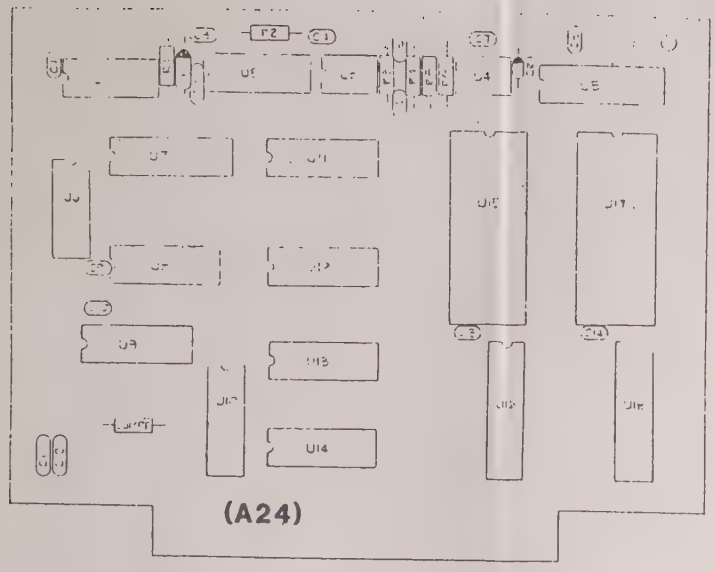
The feedback path from the negative terminal of the YIG tuning coil is through R15 to the summing junction at U3-2. A parallel "AC" feedback path, from the positive terminal of the coil through C6 and R13, is provided as a filter in order to attenuate high frequency noise.



IC #	TYPE	PIN # +5V	PIN # -5V	PIN # +15V	PIN # -15V	PIN # +18V	PIN # GND
U1	AD7542	14	—	—	—	—	3 & 12
U2	OP27	—	—	7	4	—	—
U3	OP27	—	4	—	—	7	—
U7	ILO72	—	—	8	4	—	—
U8	74LS04	14	—	—	—	—	7
U9	IH5053	12	—	13	4	—	5
U10	IH5053	12	—	13	4	—	5

FIG: 7.A13.2
YIG DRIVER PC ASSY (A13)
DWG# 304BM02401 SHT 2

REV E



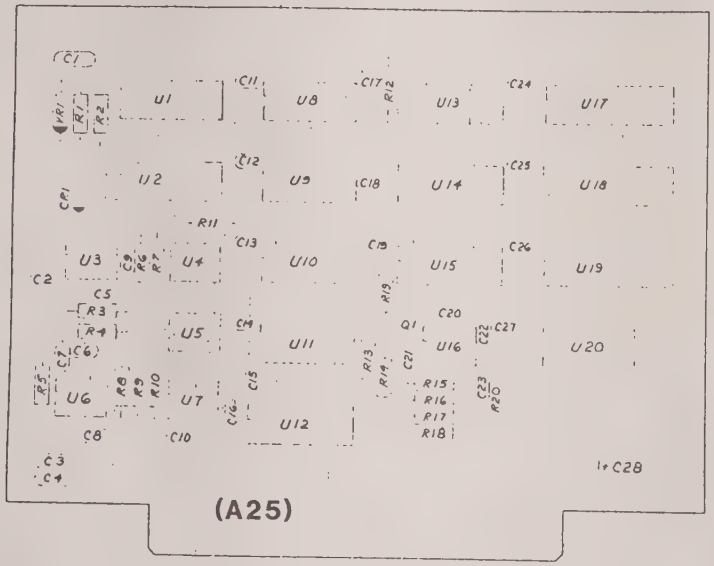


FIG: 7.A24.1
ANALOG SWEEP #2, #1 (PC ASSYS A24, A25)
DWG# 106BM03904, -03 SHT 1

REV A, A

ANALOG SWEEP LOGIC No. 1 & No. 2 -- PC Boards A25 & A24

The Analog Sweep Logic circuit is distributed over two PC boards, but is described here as a single unit. The function of the circuit is to generate, by digital means, analog signals (such as voltage ramps) required by the sweep process. The computer is able to define these signals by programming the various buffers, counters and random access memories (RAMs).

A 150 kHz clock signal is received by the circuit at pin A18 of the A25 board; this signal is used as a trigger to produce a secondary, programmable clock signal. U13 is a programmable timer (a multi-stage counter programmed by the computer via octal D flip flop U17); its output is divided further by U14 and U15, two down counters programmed via U18 and U19. The output of U15 propagates through various logic gates and is furnished to the 12 bit counters (U1, and, on the A24 board, U9, and U8). The frequency of this circuit clock is set by the computer in its programming of the counters.

U1 (A25 board) is a 12-bit binary counter; its outputs are used to program digital to analog converter U2 with an ever-increasing binary number. The DAC produces a voltage ramp in response to this numerical input. The inverting amplifier circuit (U3-6) on the DAC output includes an analog gate (U4-5) which reduces the gain of the circuit during a "narrow" analog sweep.

Two DACs are used in combination to produce a voltage ramp directly proportional to output frequency. Two counter circuits in series (U9 and U8 on the A24 board) furnish a rising 12-bit binary number to DAC U7, resulting in a ramp output at U7-1. The second DAC, U2, is programmed directly by the computer and produces, at U3-1, a fixed offset signal selected by the computer. The two DAC outputs are combined by the output amplifier circuit, U6-7 on the A25 board. An analog gate (U5-5) in the feedback path of the circuit reduces gain during "narrow" analog sweep and when a frequency extender is in use.

Two 8K-by-8 RAMs on the A24 board are loaded by the computer with data appropriate to the sweep parameters, including the location of marker frequencies. During the sweep, the memory locations are addressed successively. Of the 16 memory data lines, D0 through D11 are applied to DAC U5, creating a voltage ramp at U16-7 which proceeds from 0V to +10V and is proportional to progress through the full sweep range. Analog gate U12 supplies this ramp to the front panel 'SWEEP OUT' connector when the analog sweep mode is active (in the digital sweep mode, a ramp received from the level control board at pin A13 is substituted). Memory data line D12 goes low whenever a marker frequency is reached, and D13 through D15 are used by the computer as auxiliary "event" markers. The circuit which includes Q1, U20-1 and U16-1 responds to the UNBLANK input (pin A16) and the marker data line as follows: the 'UNBLANK/MARKER' output at pin A17 is at +5V (dark) whenever UNBLANK is low; the output is at 0V (normal) when UNBLANK is high and the marker line is high; the output is at -5V (intensified) when UNBLANK is high and the marker line is low.

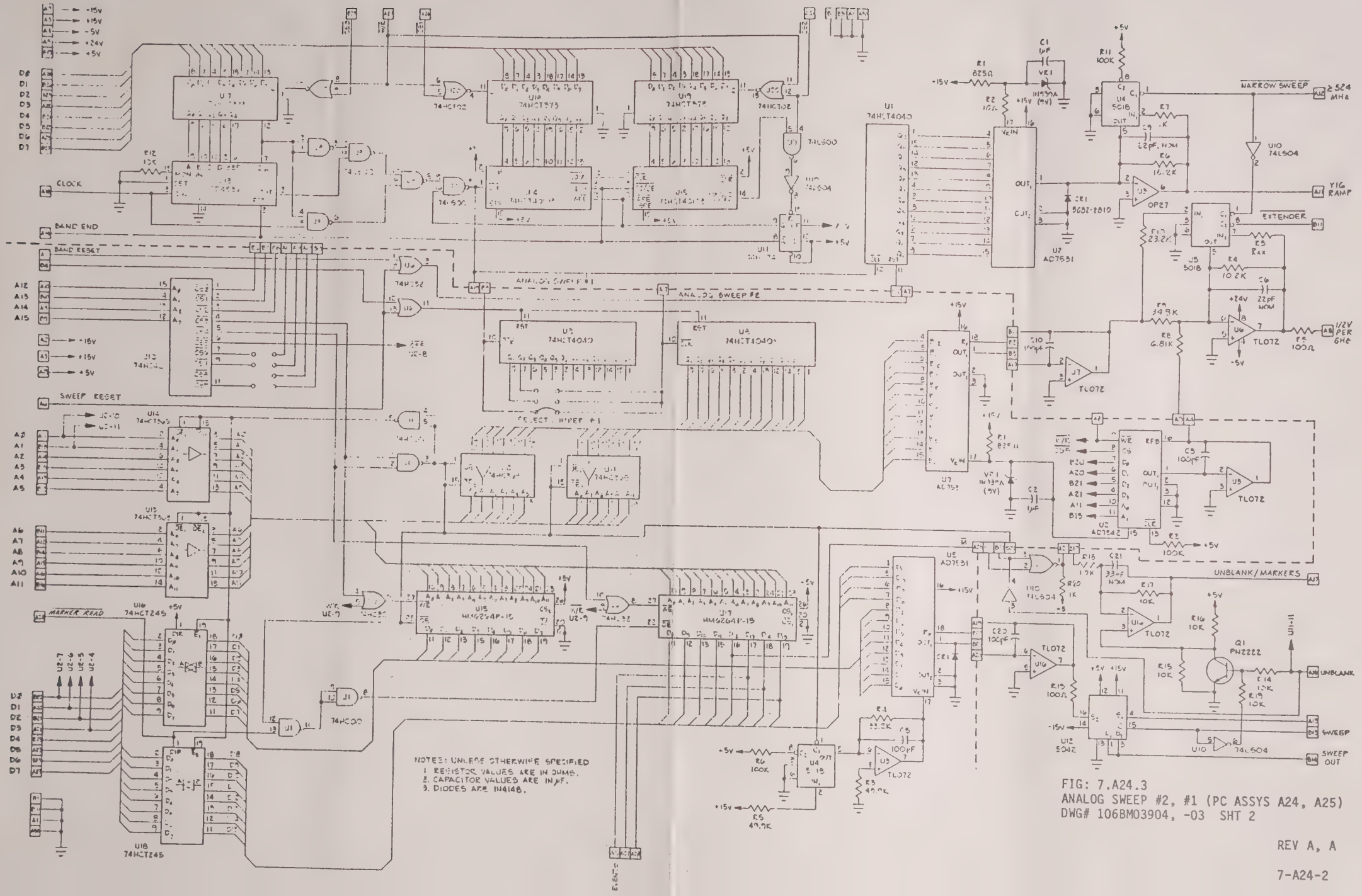


FIG: 7.A24.3
ANALOG SWEEP #2, #1 (PC ASSYS A24, A25)
DWG# 106BM03904, -03 SHT 2

REV A, A

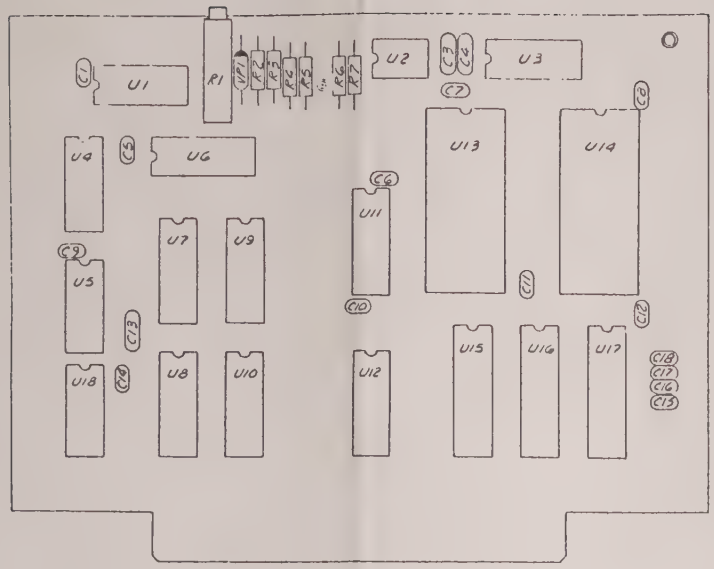


FIG: 7.A26.1
DOWNCONVERTER/LEVEL CORRECTION (A26)
DWG# 106BM04101 SHT 1

REV C

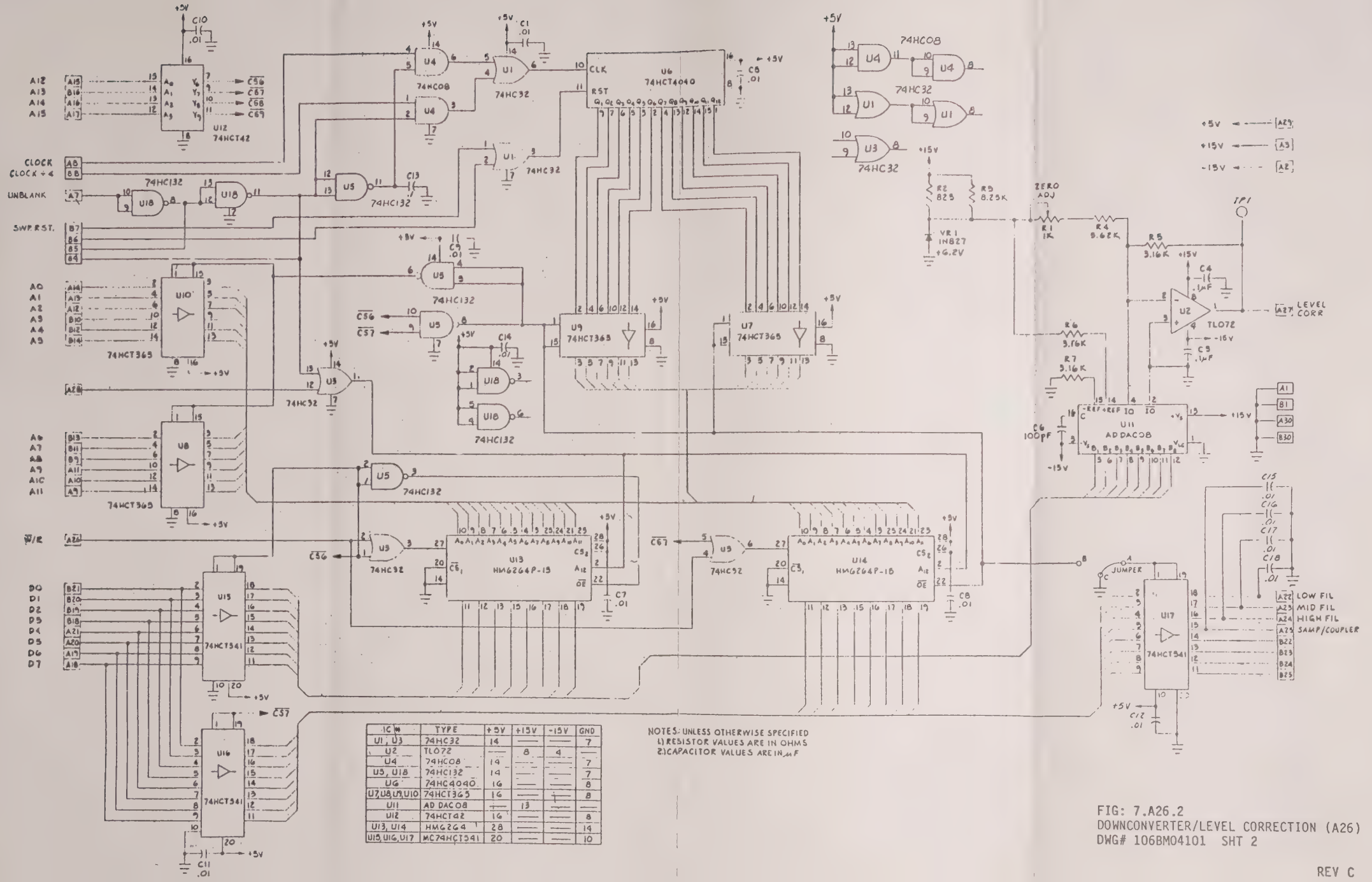
DOWNCONVERTER/LEVEL CORRECTION -- PC Board A26

During an analog sweep, this circuit performs certain level correction and RF switching functions automatically. By freeing the the computer from monitoring these functions, faster sweep operation is made possible.

The clock inputs from the analog sweep boards (see pins A8, B8) are used to drive U6, a 12-bit counter. The quarter-speed clock input (pin B8) is used at output frequencies above 2 GHz; at lower frequencies, where the frequency resolution of the level correction circuit is greater, the full-speed clock input (pin A8) is used. The counter outputs are buffered by U7 and U9, and during the sweep they are applied to the address inputs of two RAM devices (U13 and U14); as the counter increments, the memory locations are successively addressed and operating data is retrieved from RAM.

Prior to the sweep, the computer programs the RAMs with data (by way of buffers U10, U8, U15, and U16). Level correction data is loaded into U13. During the sweep, U13's output data is applied to U11, a digital to analog converter. The circuit consisting of U11 and U2 converts the RAM data into a level correction signal which is furnished to the level control circuit (A7).

The data loaded into U14 concerns path-switching in the downconverter module; the downconverter range includes all frequencies below 2 GHz and is divided into nine RF paths for purposes of harmonic filtering. The data retrieved from U14, as buffered by U17 and furnished to the module switching circuit (PC board A6), is used to activate the appropriate filter line at each point in the sweep below 2 GHz.



IC #'s	TYPE	+5V	+15V	-15V	GND
U1, U3	74HC32	14	—	—	7
U2	TL072	—	8	4	—
U4	74HC08	14	—	—	7
U5, U18	74HC132	14	—	—	7
U6	74HC4040	16	—	—	8
U7,U8,U9,U10	74HCT365	16	—	—	8
U11	AD DAC08	—	13	—	—
U12	74HCT42	16	—	—	8
U13, U14	HM6264	28	—	—	14
U15,U16,U17	MC74HCT541	20	—	—	10

NOTES: UNLESS OTHERWISE SPECIFIED
1) RESISTOR VALUES ARE IN OHMS
2) CAPACITOR VALUES ARE IN μF

FIG: 7.A26.2
DOWNCONVERTER/LEVEL CORRECTION (A26)
DWG# 106BM04101 SHT 2

REV C

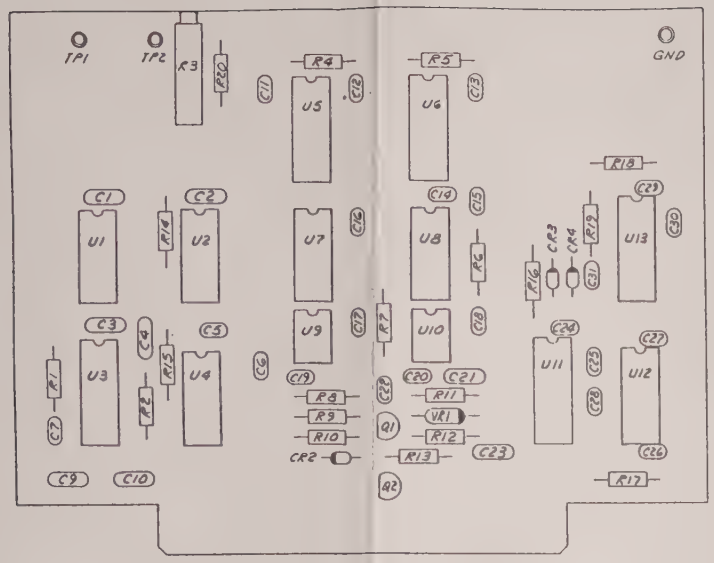


FIG: 7.A27.1
SWEEP CLK/FREQ HOLD PC ASSY (A27)
DWG# 309BM01600 SHT 1

REV E

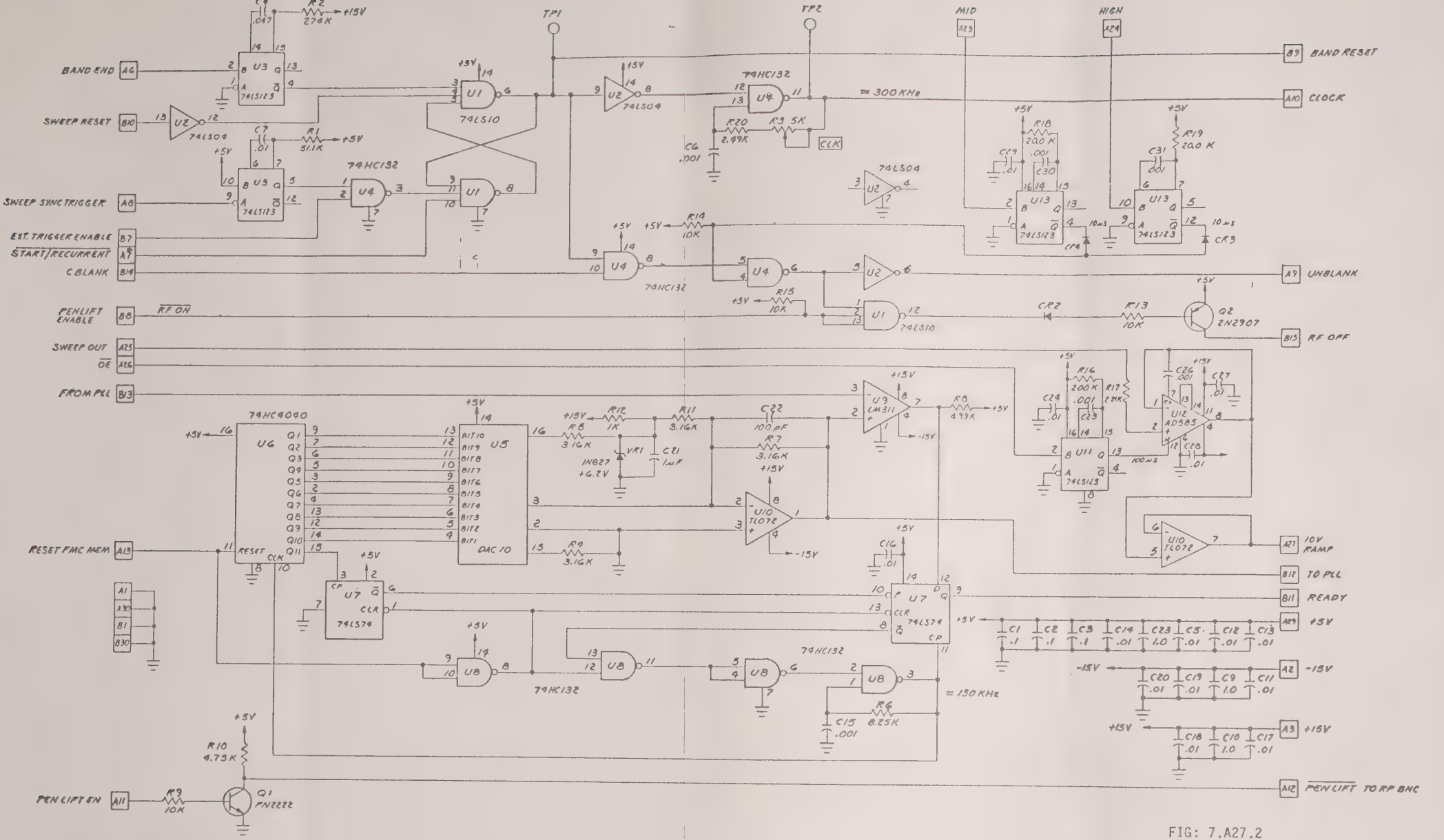
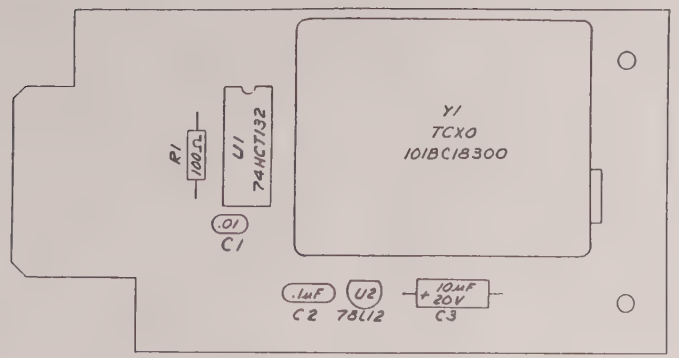


FIG: 7.A27.2
SWEEP CLK/FREQ HOLD PC ASSY (A27)
DWG# 309BM01600 SHT 2

REV E



NOTES: UNLESS OTHERWISE SPECIFIED
1.) CAPACITOR VALUES IN μF
2.) RESISTOR VALUES IN OHMS

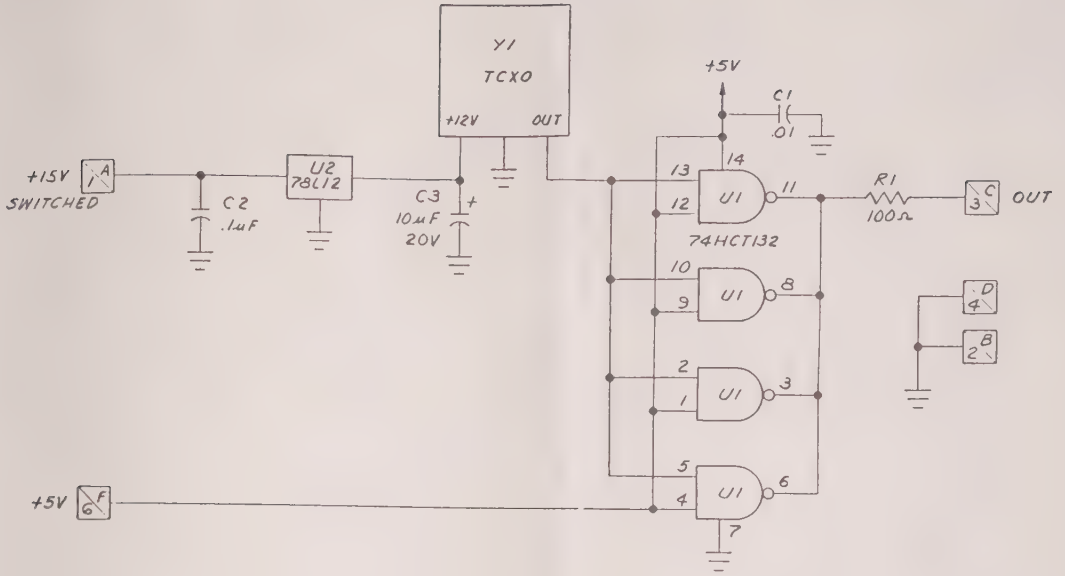


FIG: 7.A32.1
TCXO PCA ASSY (A32)
DWG# 101BM09702 SHT 1

REV B

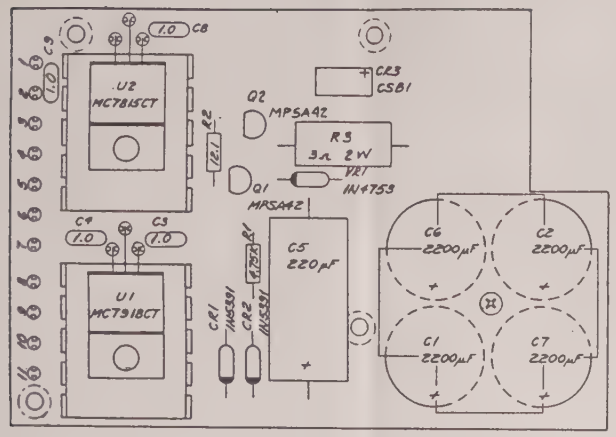


FIG: 7.A101.1
POWER SUPPLY PC ASSY (A101)
DWG# 304BM01100 SHT 1

REV D

POWER SUPPLY -- Circuit Board A101

Many of the components which make up the power supply are not located on the power supply circuit board because of their large size or cooling requirements; they are shown in this diagram for the sake of clarity. The line filter is attached to the rear panel. The transformer and the filter capacitors are mounted along the left side of the instrument, near the computer circuits. The rectifiers and voltage regulators are mounted on the heat sink at the rear of the instrument.

The transformer secondary voltages are rectified, filtered, and applied to voltage regulators to produce the instrument's power supply outputs:

Q5 provides the +5V supply used by the RF circuits.

Q1 provides the +5V supply used by the computer.

Q2 provides the -5.2V supply used by RF circuits.

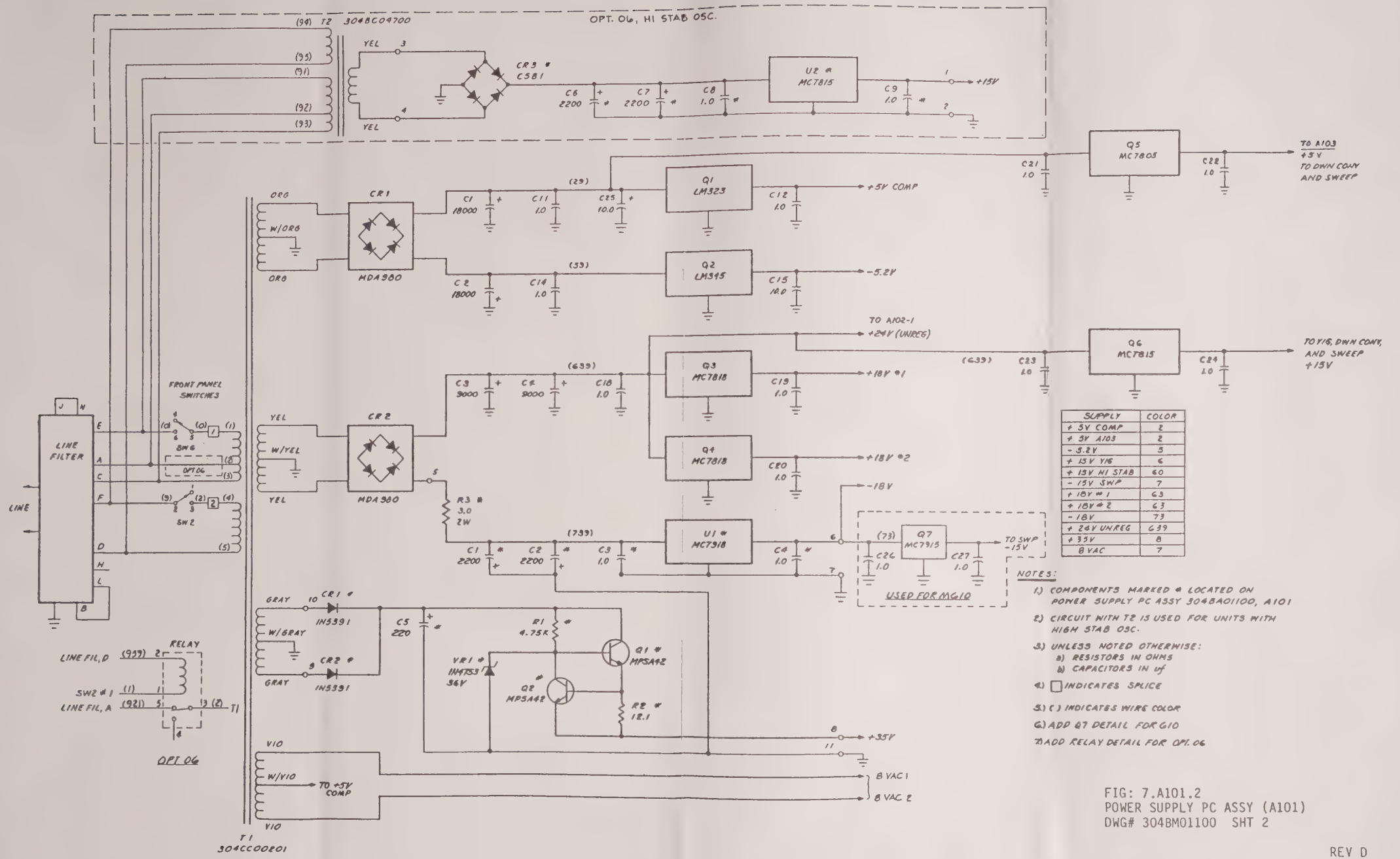
Q6 provides the +15V supply used by the YIG oscillator.

Q3 provides the +18V supply used by the RF circuits.

Q4 provides the +18V supply used by the YIG oscillator.

U1 provides the -18V supply used by the RF circuits.

UNREGULATED SUPPLIES: The +35V and 8VAC supplies are used by the fluorescent displays on the front panel. The +24V supply is used by the cooling fan and by the relays in the 10 dB step attenuator.



SUPPLY	COLOR
+ 5V COMP	2
+ 5V A103	2
- 5.2V	5
+ 15V Y/G	6
+ 15V HI STAB	60
- 15V SWP	7
+ 18V # 1	63
+ 18V # 2	63
- 18V	73
+ 24V UNREG	639
+ 35V	8
8 VAC	7

NOTES:

1) COMPONENTS MARKED # LOCATED ON POWER SUPPLY PC ASSY 304BA01100, A101
2) CIRCUIT WITH T2 IS USED FOR UNITS WITH HIGH STAB OSC.
3) UNLESS NOTED OTHERWISE:
   a) RESISTORS IN OHMS
   b) CAPACITORS IN uf
4) ☐ INDICATES SPLICE
5) ( ) INDICATES WIRE COLOR
6) ADD Q7 DETAIL FOR G10
7) ADD RELAY DETAIL FOR OPT. 06

FIG: 7.A101.2
POWER SUPPLY PC ASSY (A101)
DWG# 304BM01100 SHT 2

REV D

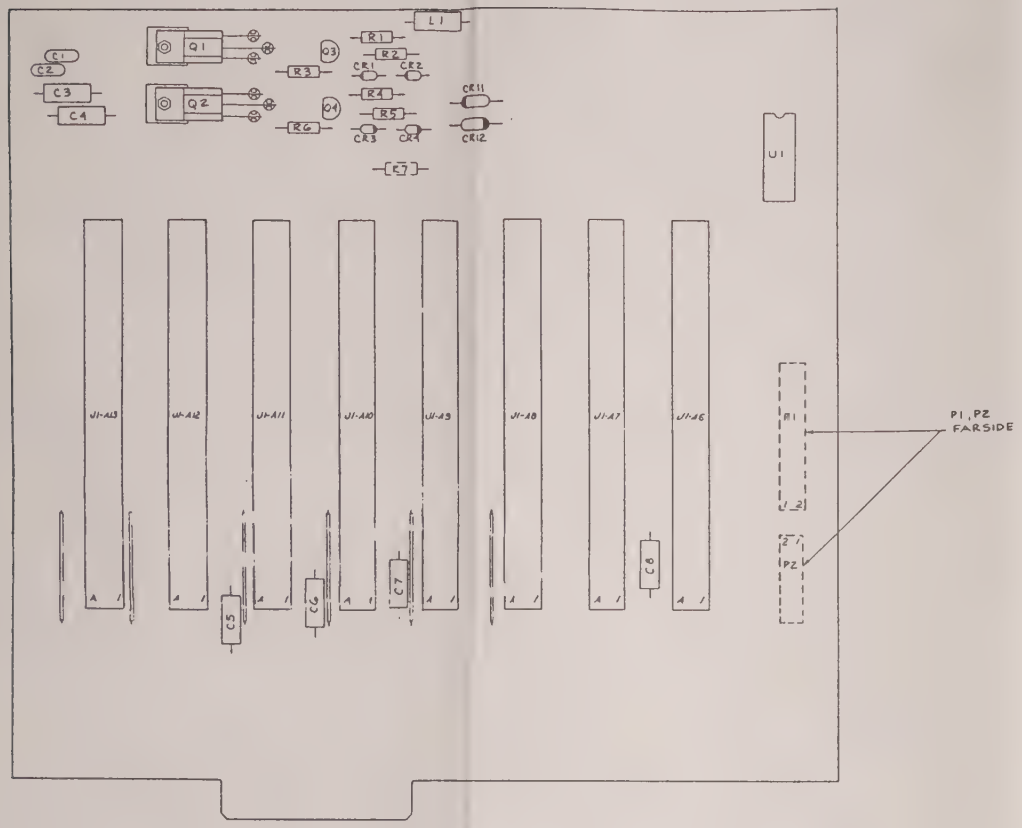


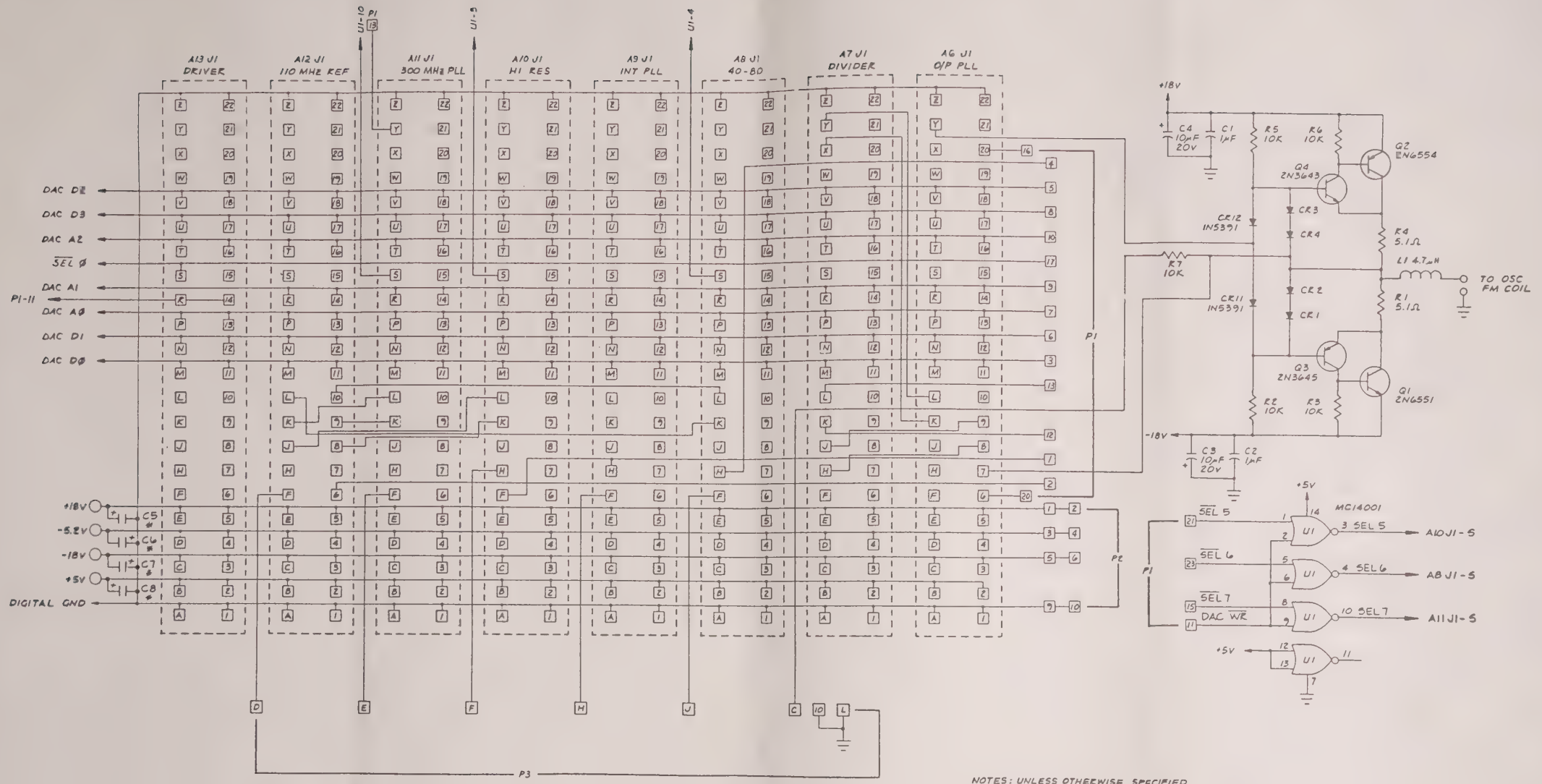
FIG: 7.A103.1
RF BUS PC ASSY (A103)
DWG# 304BM02900 SHT 1

REV E

RF BUS -- PC Assy A103

This bus board provides interconnections between the various RF circuit boards (A6 through A13) which are inserted into it. In addition, the bus board houses a select-line decoder (U1) used by the PLL circuits and the FM driver circuit (Q1 through Q4, etc.).

The FM driver is essentially the output stage of the output phase lock loop circuit (A6). It is a class-B amplifier providing sufficient current gain to drive the FM tuning coil of the YIG oscillator. An inductor on the output (L1) is used as a filter to eliminate frequencies above 2 MHz; this prevents high-frequency noise in the PLL circuit from contributing spurious frequency components to the RF output spectrum.



NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTOR VALUES ARE IN OHMS.
2. CAPACITOR VALUES ARE IN uF.
3. DIODES ARE IN4148.
4. * C5-8 ARE 10uF 20V

FIG: 7.A103.2
RF BUS PC ASSY (A103)
DWG# 304BM02900 SHT 2

REV E

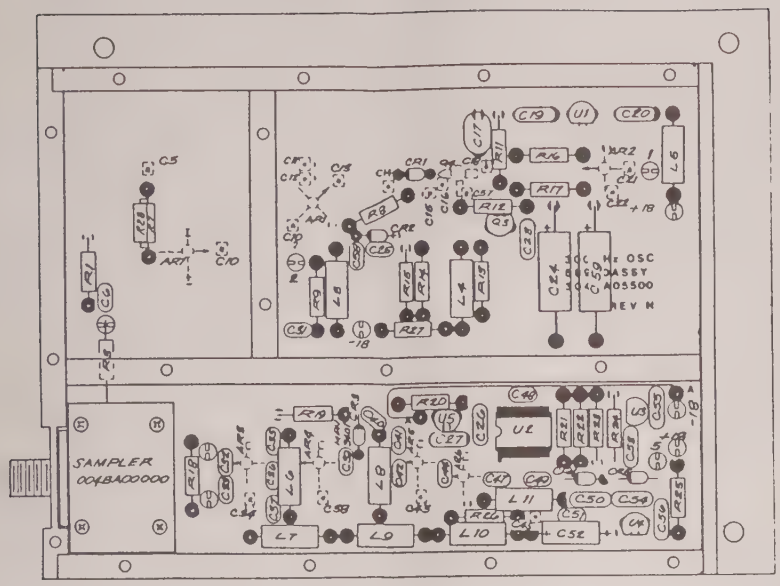


FIG: 7.A104.1
300 MHz OSC PC ASSY (A104)
DWG# 304BM05500 SHT 1

REV H

300 MHz OSCILLATOR/DRIVER -- Circuit Board A104

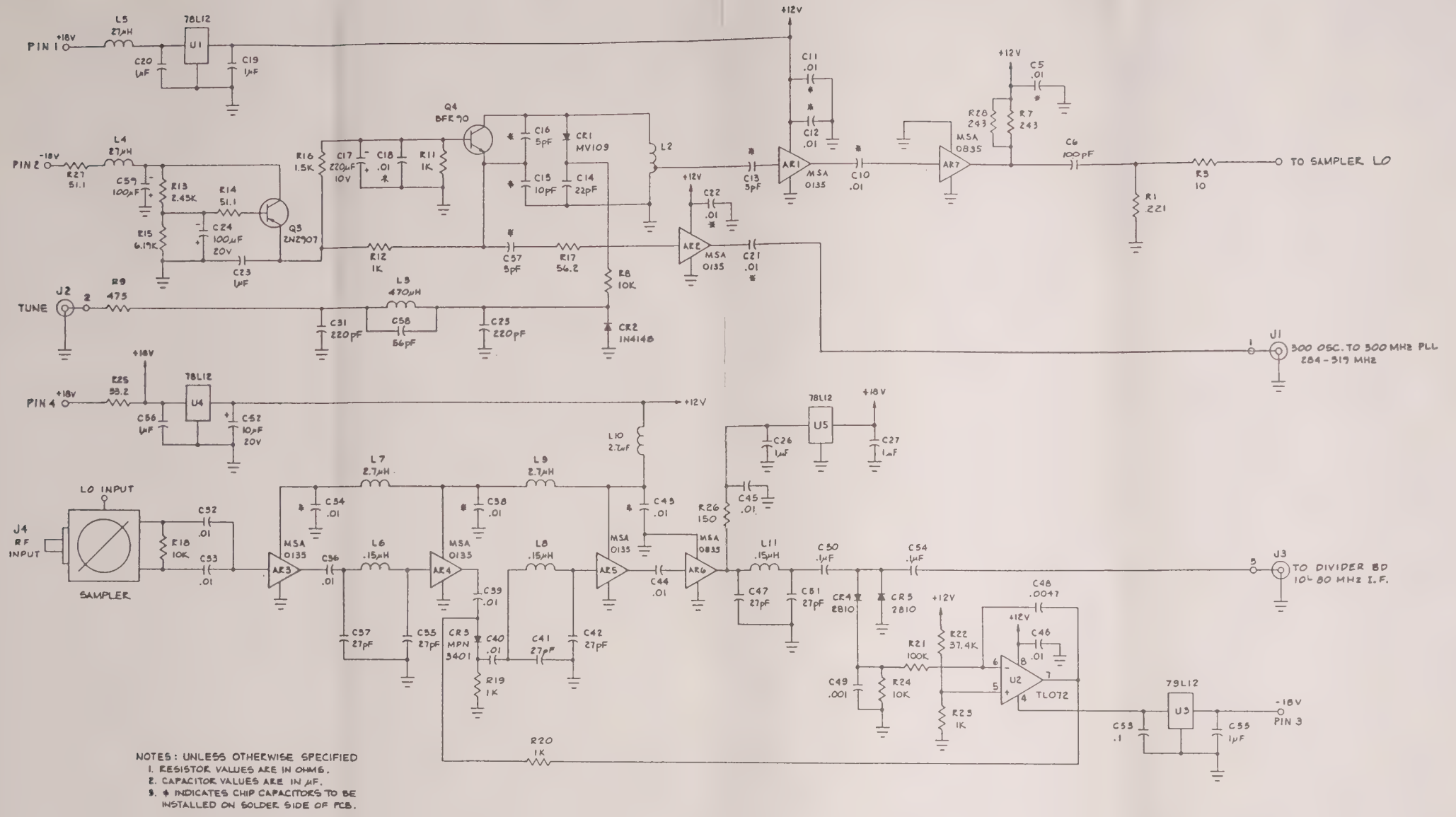
This circuit board is encased in an aluminum housing and mounted directly beneath the RF module; it is not normally accessible to service in the field.

The tuning output from the 300 MHz PLL circuit board (A11) is received at J2. A 1 MHz trap (L3, etc.) reduces the reference-frequency component contributed by the PLL's phase detector. The filtered control signal is applied to the voltage controlled oscillator (Q4). A sample of the VCO frequency is fed back to the PLL circuit (see AR2) in order to permit phase lock. The VCO operates over a range of 284 to 319 MHz.

The VCO output frequency is taken at L2; this inductor is implemented as a conductive strip in the printed circuit artwork and is tapped very close to ground in order to reduce the load on the oscillator and insure stability. The VCO frequency is amplified by AR1 and AR7 to meet the input level requirement of the sampling mixer (about 4 Vpp).

The sampling mixer is a miniature hybrid RF circuit which combines a mixer with a step-recovery diode multiplier. The multiplier (to which the VCO frequency from the driver is applied) generates numerous harmonic multiples of its input frequency. The harmonics are used as one input to the RF mixer; the other input (see J4) is a sample of the YIG oscillator frequency, obtained from a coupler in the RF module. Because one mixer input is a harmonic series, the intermediate frequency output includes numerous sum and difference frequency components.

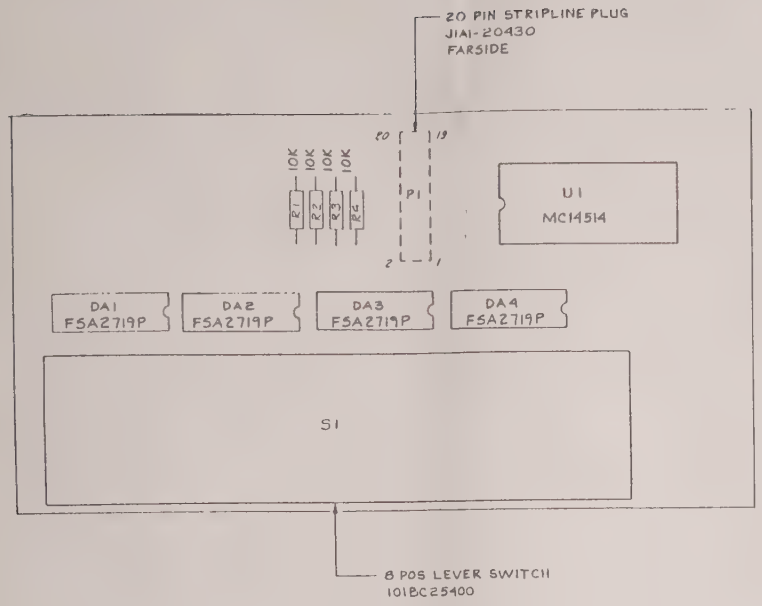
The mixer IF must be filtered and amplified in order to isolate one IF component in the range of 10-80 MHz. The power level of the IF output is very low; AR3, AR4 and AR5 each provide about +19 dB of gain, and the final amplifier stage (AR6) provides about +33 dB of gain. Three low-pass filters (L6, L8 and L11) roll off sharply above 130 MHz to eliminate harmonics of the IF. The amplitude of the sampling mixer IF is highly variable with frequency; in order to obtain a flat frequency response, an AGC circuit is added (U2-7). Diodes CR4 and CR5 are used by the circuit as signal level detectors; a correction voltage is produced and is applied to attenuator diode CR3 in order to maintain a 1 Vpp IF output at J3.



NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTOR VALUES ARE IN OHMS.
2. CAPACITOR VALUES ARE IN μF.
3. # INDICATES CHIP CAPACITORS TO BE INSTALLED ON SOLDER SIDE OF PCB.

FIG: 7.A104.2
300 MHz OSC PC ASSY (A104)
DWG# 304BM05500 SHT 2

REV H



8-POSITION LEVER SWITCH -- PC Board A107

U1 is a 4-to-16 line decoder; it is used by the computer to strobe the front panel lever switches. The 4-bit strobe number is received (see P1-7,8,9,10) from the computer (the A1 PC board, J3) and is decoded into strobe lines. Eight of these lines are applied to S1, the 8-position lever switch on this board (it is used for frequency setting). Five other strobe lines produced by U1 are applied (see P1-13,14,15,16,18) to the 5-position lever switch on PC board A109. The position of each switch is expressed as a four-bit number on the output of S1 and is returned to the computer (see P1-3,4,5,6).

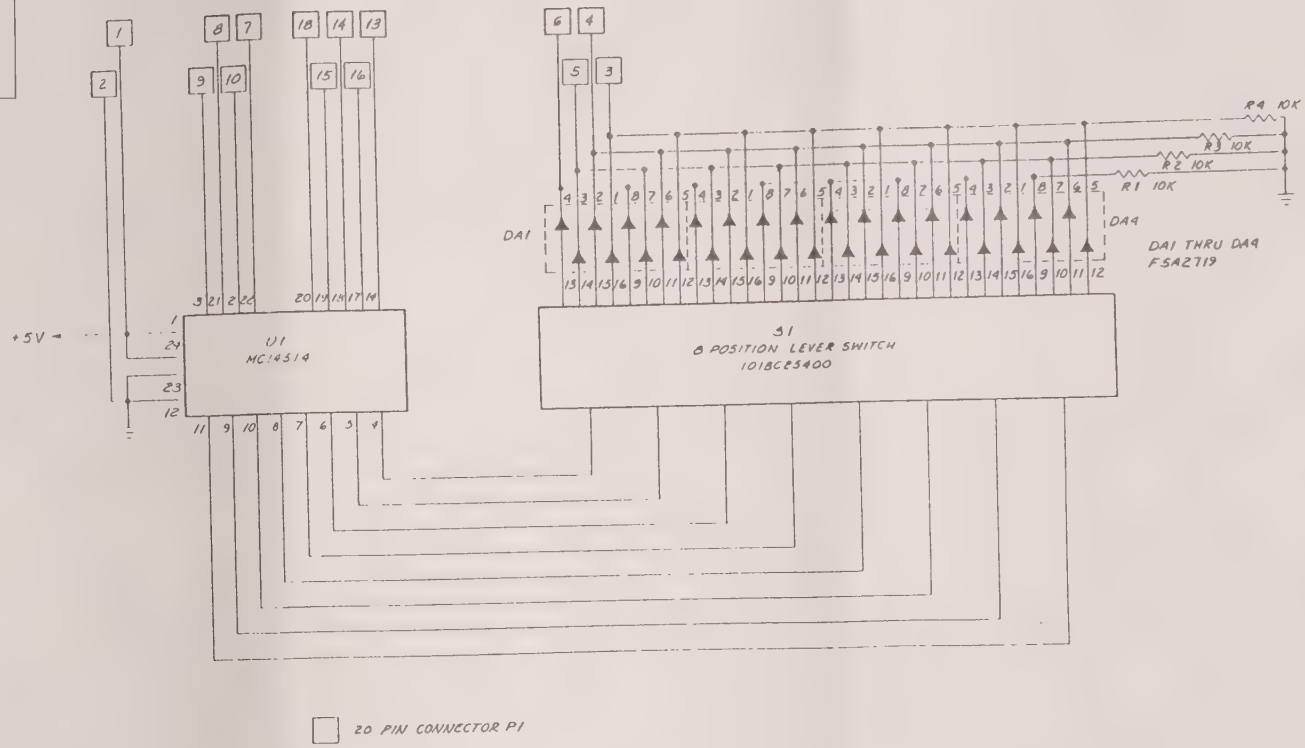
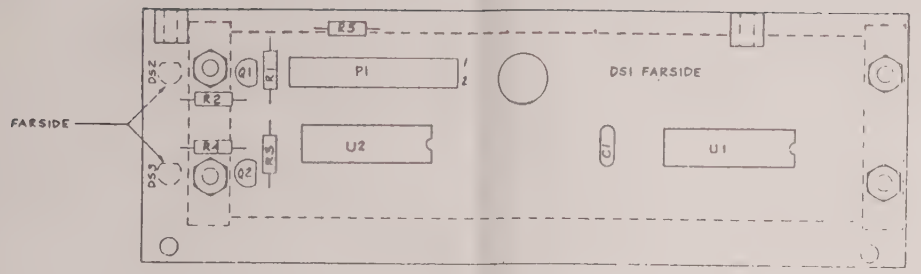


FIG: 7.A107.1
8 POSITION LEVER SWITCH (A107)
DWG# 304BM02100 SHT 1

REV C



FREQUENCY DISPLAY -- PC Board A108

This board houses the frequency display and its drivers. DS-1 is an 8-digit fluorescent display, with separate inputs for segment and digit select lines. The select lines are driven by U1 and U2, which in turn are driven by the computer (see J1 of PC board A1). In addition, the 'LOCK' and 'REMOTE' indicators, driven by inputs from J3 of PC board A4, are located on this board.

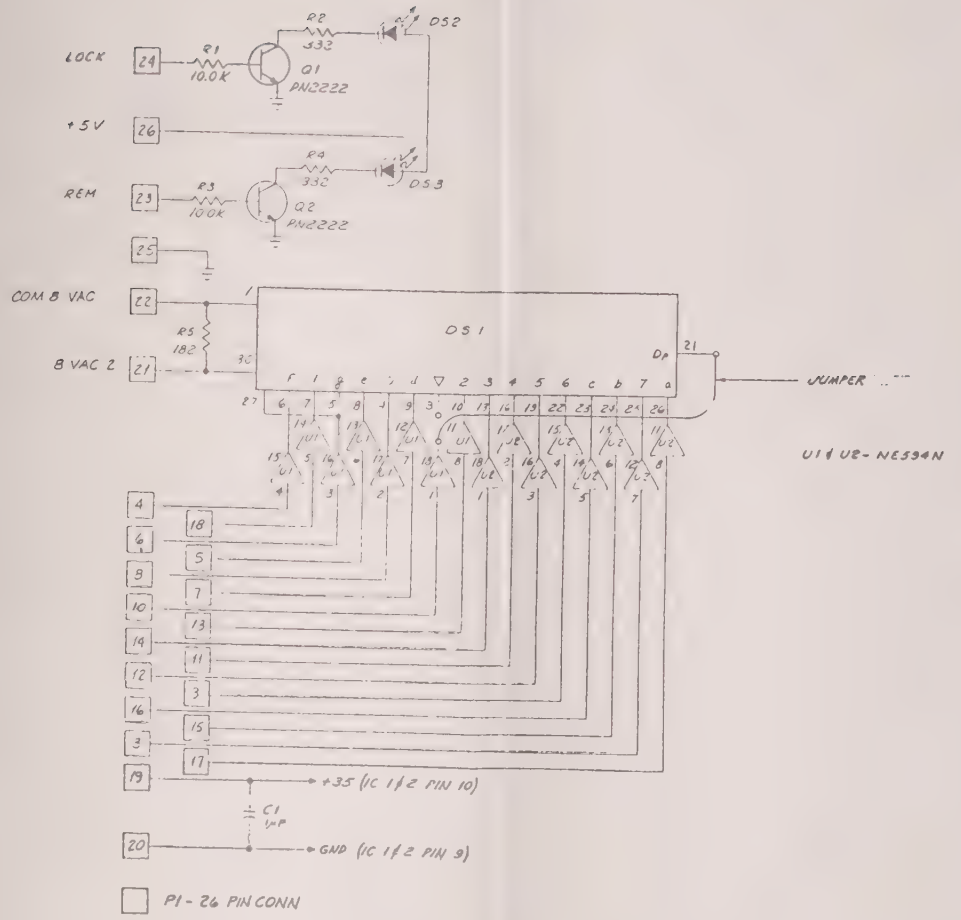
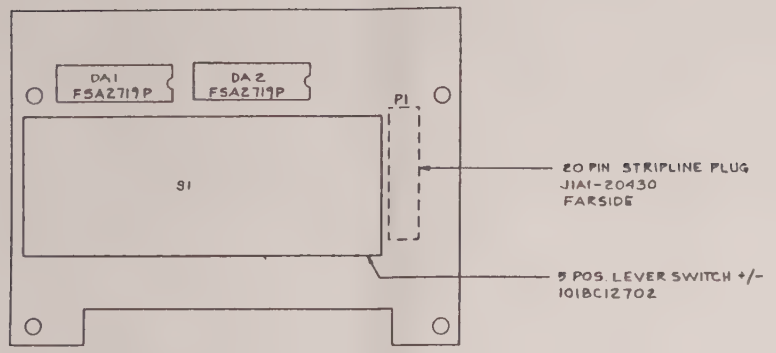


FIG: 7.A108.1
FREQUENCY DISPLAY PC ASSY (A108)
DWG# 304BM02602 SHT 1

REV B



5-POSITION LEVER SWITCH -- PC Board A109

The 5-position lever switch is used to select RF level. The five strobe lines are received from PC board A107. The position of each switch is expressed as a four-bit number which is returned to the computer (see P1-3,4,5,6).

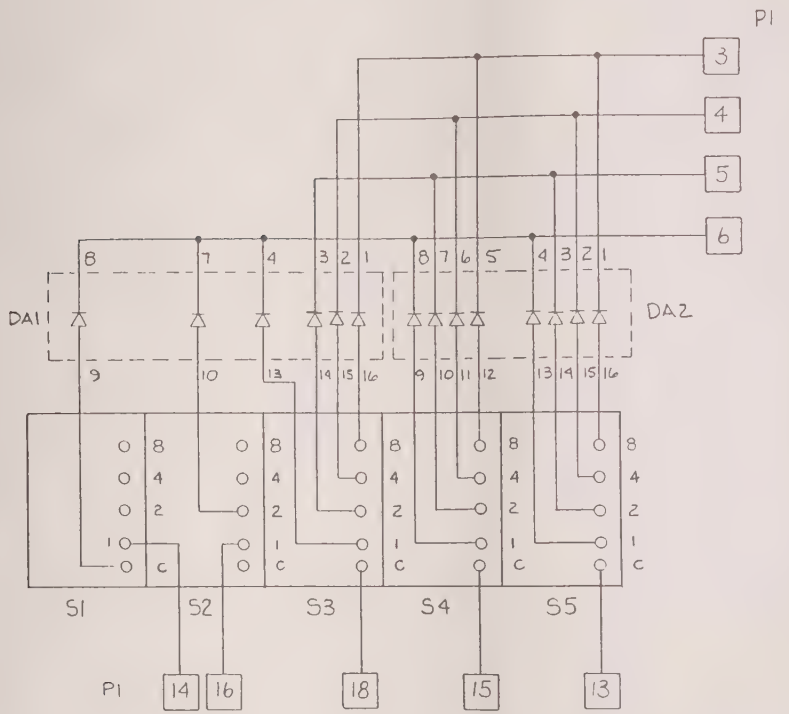
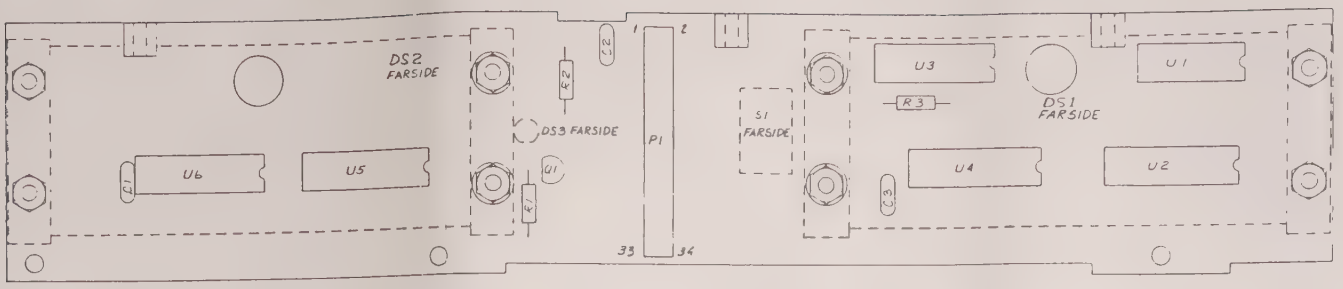


FIG: 7.A109.1
5-POSITION LEVER SWITCH (A109)
DWG# 304BM02500 SHT 1

REV B



MOD/POWER DISPLAY -- PC Board A110

This board houses the fluorescent displays used by the modulation and power meters. DS2 is the power display; control lines from the computer (see J1 of PC board A1) select the appropriate digits and segments. These control inputs are buffered by display drivers U5 and U6. DS1 is the modulation display. The inputs to its display drivers come from the level control circuit (see J1 of PC board A5); the segment select lines are decoded by U3 from a BCD input produced by the level control circuit. The inputs from the modulation mode switch (S1) are decoded by U1 to determine placement of the decimal point. DS3, the 'LEVELED' indicator, is controlled by an input from the computer (see J3 of PC board A4).

FIG: 7.A110.1
MOD/POWER DISPLAY PC ASSY (A110)
DWG# 304BM02300 SHT 1

REV D

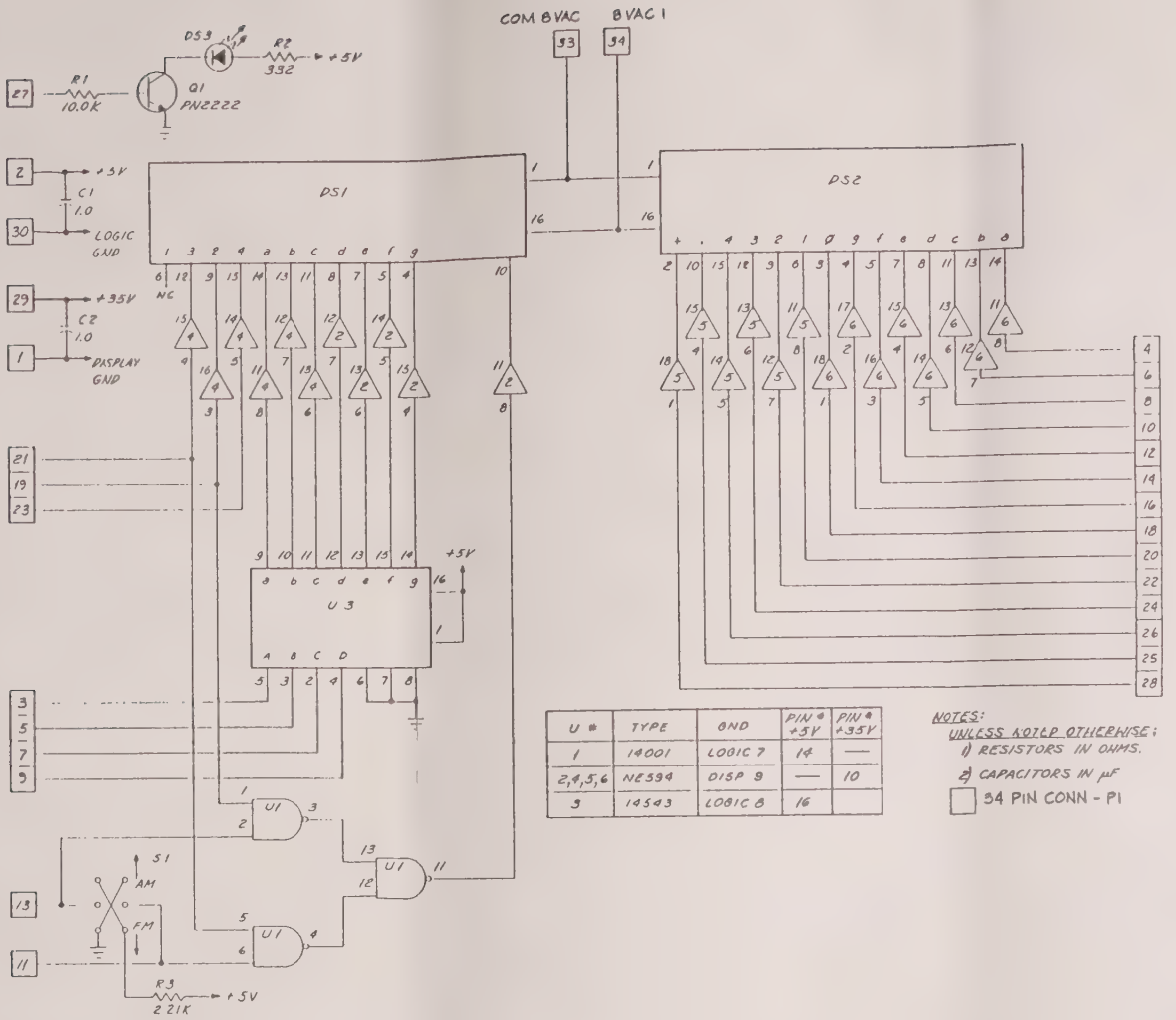
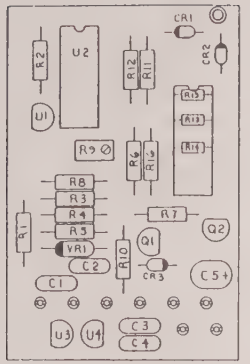


FIG: 7.A110.2
MOD/POWER DISPLAY PC ASSY (A110)
DWG# 304BM02300 SHT 2

REV D



TEMPERATURE COMPENSATION CIRCUIT -- PC Board A112

This circuit provides correction signals in response to internal temperature changes in the instrument. U1 is a temperature sensor, producing an output voltage proportional to temperature. The sensor voltage, amplified by U2-1, is furnished to two circuits. The circuit consisting of U2, Q1 and Q2 controls the speed of the instrument's cooling fan, switching to high speed when the sensor voltage indicates a temperature in excess of +40°C. The circuit consisting of U2-14, CR1, CR2, etc., provides a correction signal to the level control circuit (PC board A5). This correction signal is required because the sensitivity of the level detector changes with temperature, and this would cause a level error if not compensated. Each detector has a unique temperature response. During production testing, R13, R14, and R15 are selected and the 'ZERO' pot (R9) is adjusted to match the response curve of the instrument's particular detector. THESE VALUES SHOULD NOT BE CHANGED.

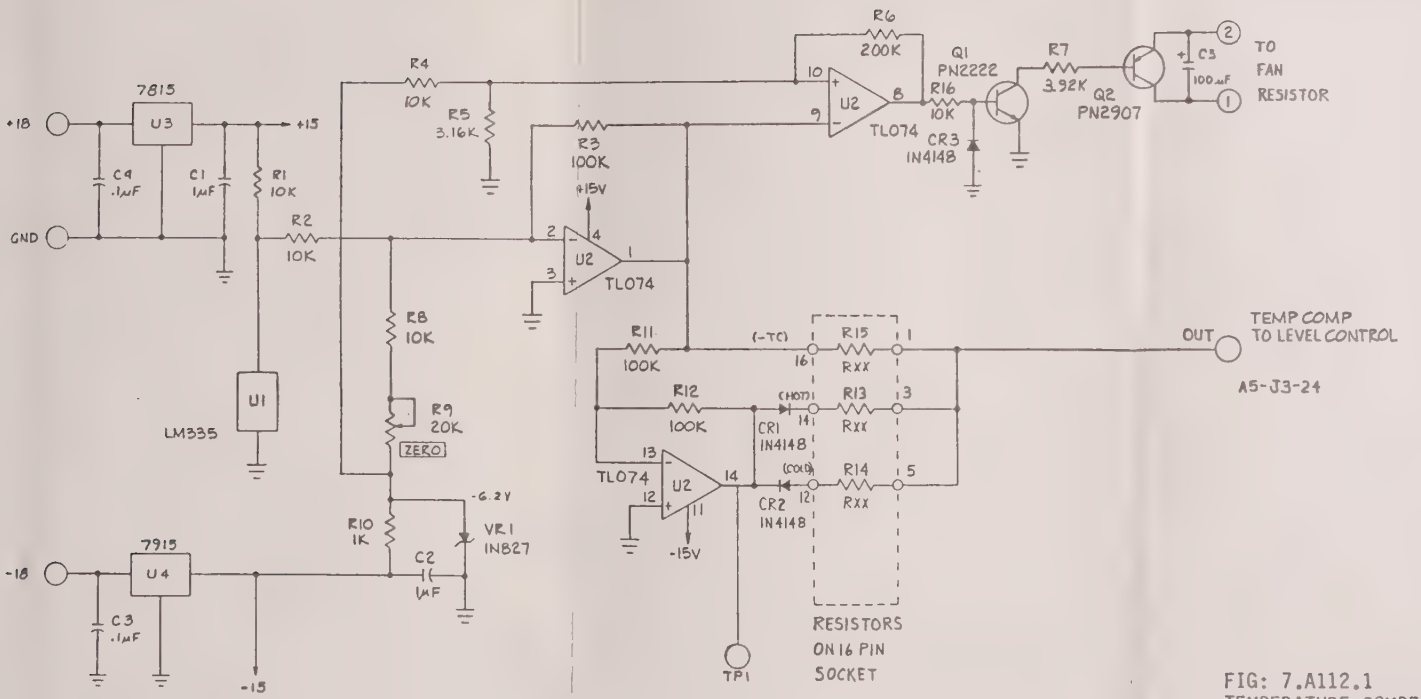


FIG: 7.A112.1
TEMPERATURE COMPENSATION PC (A112)
DWG# 304BM04600 SHT 1

REV E

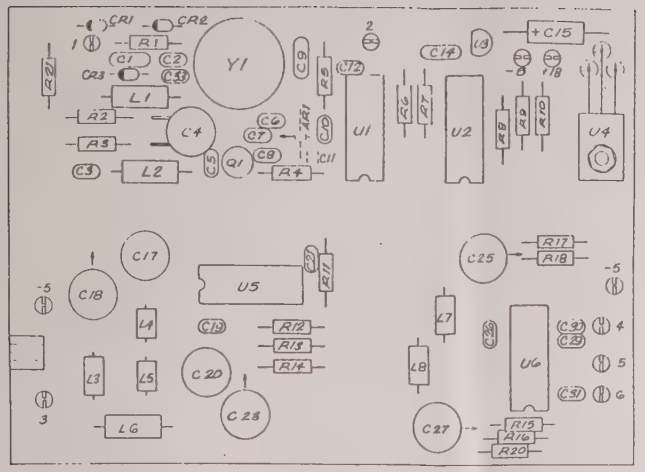


FIG: 7.A113.1
OSCILLATOR/MULTIPLIER PC ASSY (A113)
DWG# 304BM05700 SHT 1

REV B

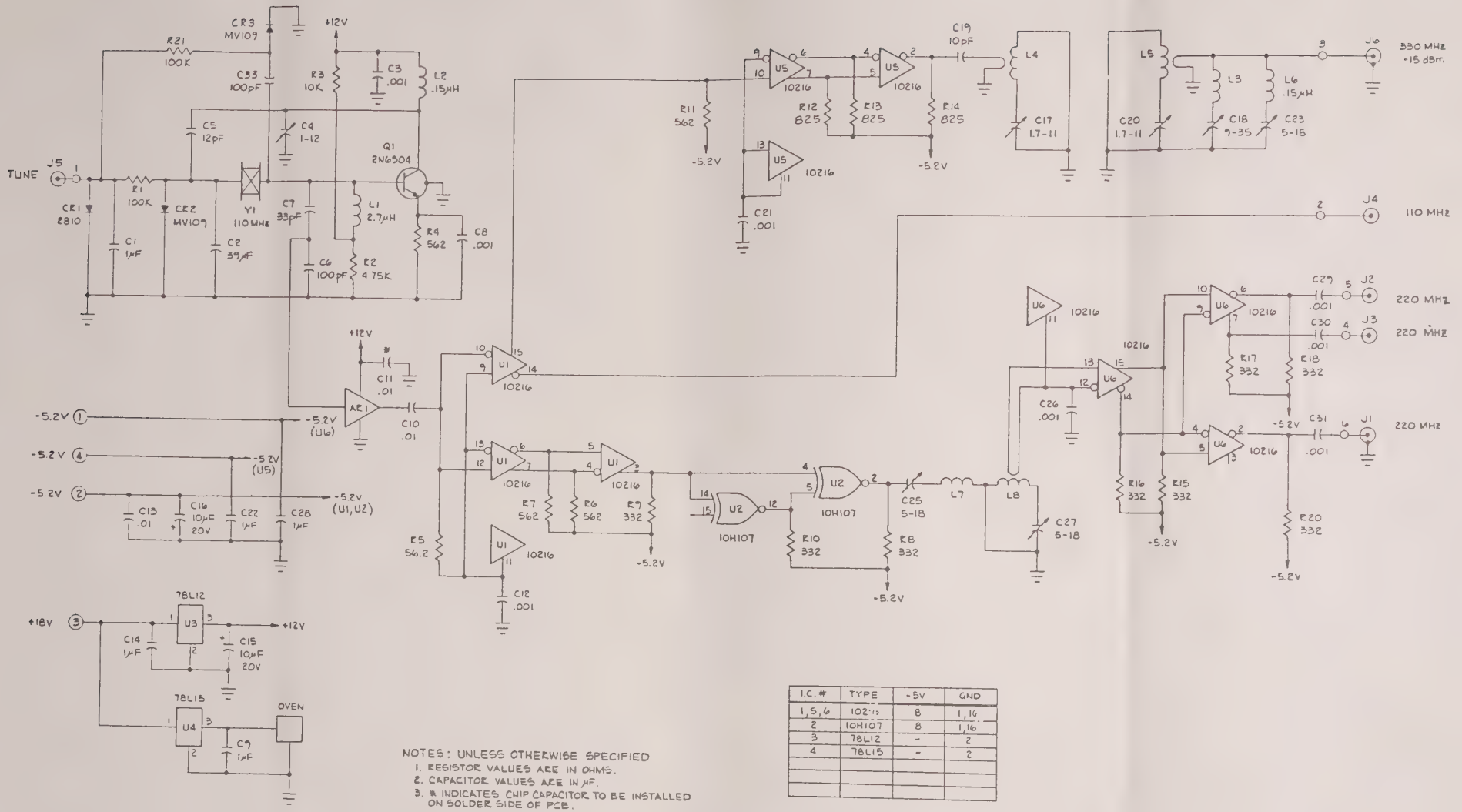
110 MHz OSCILLATOR/MULTIPLIER -- PC Assy A113

This circuit is the source for the 220 MHz and 330 MHz reference signals used by various phase lock loop circuits in the synthesizer.

The voltage controlled crystal oscillator (Q1, etc.) uses a quartz crystal resonator (Y1); a tuned circuit (L2, etc.) restricts the crystal to an oscillation mode at 110 MHz. The VCXO is fine tuned by a voltage input (J5) from the 110 MHz PLL circuit (A12). Its output signal is amplified by AR1 and buffered by line receiver U1. The buffered 110 MHz signal is fed back to the PLL (A12) at J4, and is also furnished to the frequency doubler and frequency tripler circuits.

Two exclusive-NOR gates (U2) form a frequency doubler (the output toggles on both the leading and trailing edges of the input). The resulting 220 MHz frequency is inductively coupled to a buffer stage (U6) through a band-pass filter (L7/L8, etc.). Two trimmer caps (C25 and C27) provide peaking adjustment. The output buffers (U6) provide samples of this 220 MHz signal to other circuits in the synthesizer. J1 provides a 220 MHz output to the 40-80 MHz PLL (A8), or to the High Resolution PLL (A10) for instruments with option 03. J3 provides a 220 MHz output to the Intermediate PLL (A9) for instruments with option 03. J2 is an auxiliary 220 MHz output and is not normally used.

The frequency tripler takes advantage of the large third-harmonic component present in any square wave. The line receivers of U5 produce a square 110 MHz signal which is inductively coupled through a band-pass circuit (L4/L5, etc.). C17, and C20 provide peaking adjustment. Two band-stop filters on the output (L3, L6 etc.) remove the fundamental and the second harmonic of the VCXO frequency (C18 and C23 permit fine tuning of these filters). The 330 MHz output is not buffered, because the circuit to which it is furnished (the 300 MHz PLL, A11) does not require a high power input.



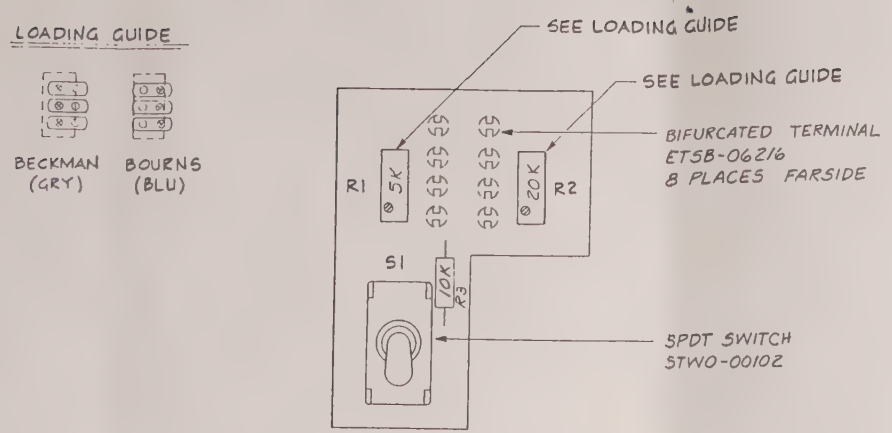
I.C. #	TYPE	-5V	GND
1,5,6	10216	8	1,16
2	10H107	8	1,16
3	78L12	-	2
4	78L15	-	2

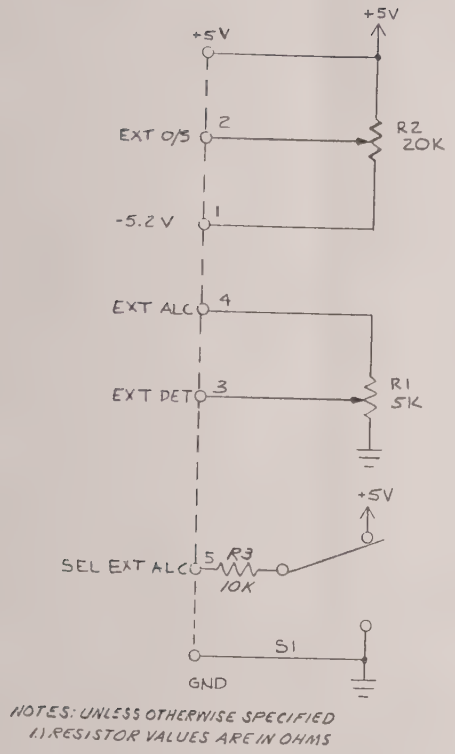
NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTOR VALUES ARE IN OHMS.
2. CAPACITOR VALUES ARE IN μF.
3. # INDICATES CHIP CAPACITOR TO BE INSTALLED ON SOLDER SIDE OF PCB.

O INTERNAL PINS
◯ EXTERNAL PINS

FIG: 7.A113.2
OSCILLATOR/MULTIPLIER PC ASSY (A113)
DWG# 3048M05700 SHT 2

REV B





EXTERNAL ALC POT SWITCH -- Circuit Board A117

This circuit, which is mounted at the rear panel of the instrument, provides three inputs to the level control system, all of which are related to external ALC operation.

The 'ENABLE' switch (S1) is used by the operator to select or deselect the external ALC mode. It furnishes a TTL high or low to the level control circuit.

The input from the external detector is received at pin 4 (from the connector on the rear panel). The detector signal is taken from the wiper of R1 and is furnished to the level control circuit via pin 3. R1 is the'GAIN' pot and is used to calibrate the leveling loop at the high end of its power range, in order to match the slope of the external detector's transfer curve.

R2 is the 'OFFSET' potentiometer; the voltage taken from its wiper at pin 2 is furnished to the level control circuit. The offset voltage is used to calibrate the leveling loop at the low end of its power range, in order to match the intercept point of an external detector's transfer curve.

FIG: 7.A117.1
EXT ALC POT SWITCH (A117)
DWG# 304BM09000 SHT 1

REV C

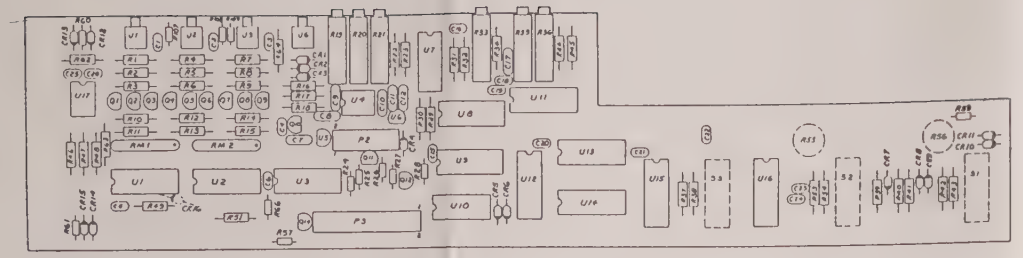


FIG: 7.A118.1
MODULATION CONTROL PC ASSY (A118)
DWG# 308BM00301 SHT 1

REV J

MODULATION CONTROL -- PC Board A118

This circuit provides modulation signals to the RF module and other modulation-related circuits. In addition to the AM, FM, and PULSE modulating signals, termination and filter-select inputs for the module are furnished by this circuit board. This circuit board is both a function generator and a switching network for signals generated elsewhere.

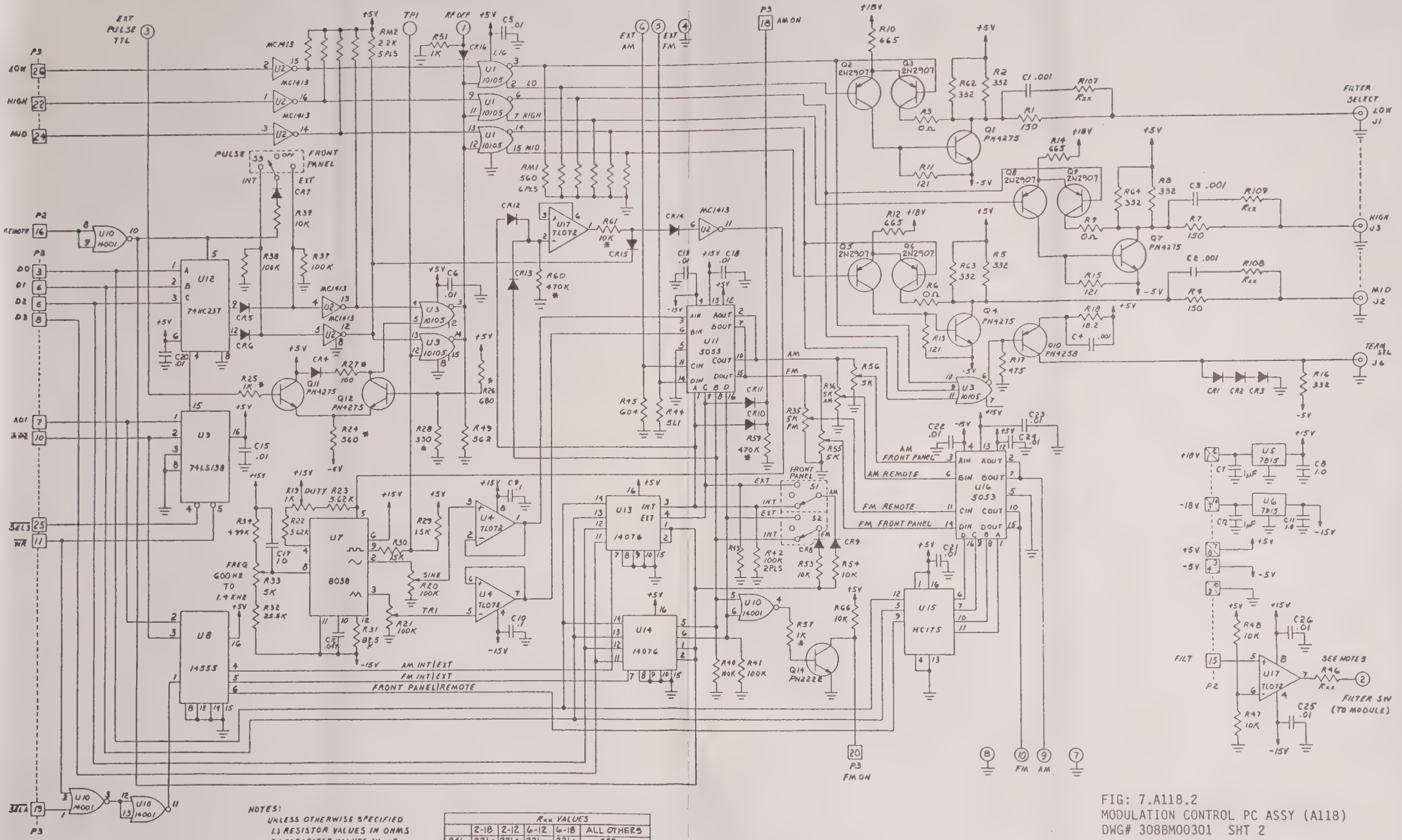
Internally generated modulating signals are produced by the function generator chip, U7. This IC produces simultaneous square wave, sine wave, and triangle wave outputs at 1 kHz. The output rate is calibrated by means of R33. R19, R20 and R21 are used to calibrate square wave duty cycle, AM sine amplitude and FM triangle amplitude, respectively. The square wave output (used in pulse modulation) is supplied via U3-12 to the gates of U1 and the pulse modulation output stage. The AM sine output is supplied via U4-3 and analog gate U11-3 to the AM output stage. The FM triangle output is supplied via U4-5 and analog gate U11-6 to the FM output stage. When the instrument is not in any internal modulation mode, the input at U7 disables the function generator so that it will not cause interference with external modulation functions.

Most of the circuit board is devoted to switching circuits which must distinguish between different types of control settings: internal vs. external modulation, remote vs. front panel control. Also, the switching circuits are used to select AM, FM, or Pulse modes (or combination thereof).

The 'REMOTE' input at P2-16 is inverted by U10-10; this 'REMOTE/NOT' line is tied to several circuits and causes them to ignore front panel modulation settings when the instrument is under remote control. The analog gates of U16 distinguish between remote and local AM and FM. The front panel modulation switch settings are used to distinguish between internal and external modulation modes (several front panel components are included in the schematic diagram for this circuit board for the sake of clarity). When external modes are in use, the inputs at pin 6 (AM), pin 5 (FM) and pin 3 (Pulse) are substituted for the internally generated signals. U2-13 and U2-12 distinguish between internal and external pulse modulation; the analog gates of U11 distinguish between internal and external AM and FM.

The output at pin 9 furnishes the AM modulating output to the level control board. The output at pin 10 furnishes the FM modulating output to the output PLL. Control signals to select AM and FM modes are also furnished to those circuits via P3-18 and P3-20.

The pulse modulation output stage must distinguish between the filter bands into which the RF module is divided. The LOW, MID and HIGH inputs from the computer (see P3-22, -24, -26) divide the pulse modulation output stage into three ranges, each with its own output driver (see Q1-Q3, etc.). The gates of U1 provide the modulation signal to all sections. In addition to the modulation drivers, a termination output is provided to the module which is the complement of the driver output (the termination is needed during "off" pulses to prevent the modulator from reflecting the signal back to the RF source and disturbing the level control system). A filter switch output is also provided (see U17-7) for the module; it is needed to select the high or low filter band for the RF coupler and/or level coupler in the RF module, and is triggered by a filter setting control line from the computer (see P2-15).



NOTES:
UNLESS OTHERWISE SPECIFIED
1.) RESISTOR VALUES IN OHMS
2.) CAPACITOR VALUES IN uF
3.) ALL DIODES ARE IN4148
4.) * 1/8 WATT

	Rxx VALUES				
	2-18	2-12	6-12	6-18	ALL OTHERS
R46	221Ω	221Ω	221Ω	221Ω	825Ω

FIG: 7.A118.2
MODULATION CONTROL PC ASSY (A118)
DWG# 308BM00301 SHT 2

REV J

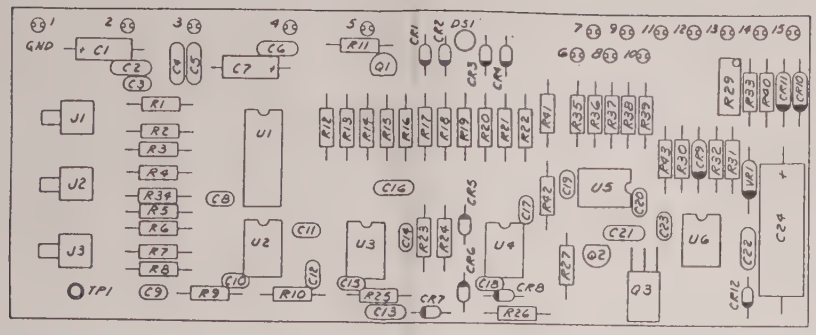


FIG: 7.A119.1
DOWNCONVERTER PLL PC ASSY (A119)
DWG# 304BM11600

REV D

DOWNCONVERTER PHASE LOCK LOOP -- PC Board A119

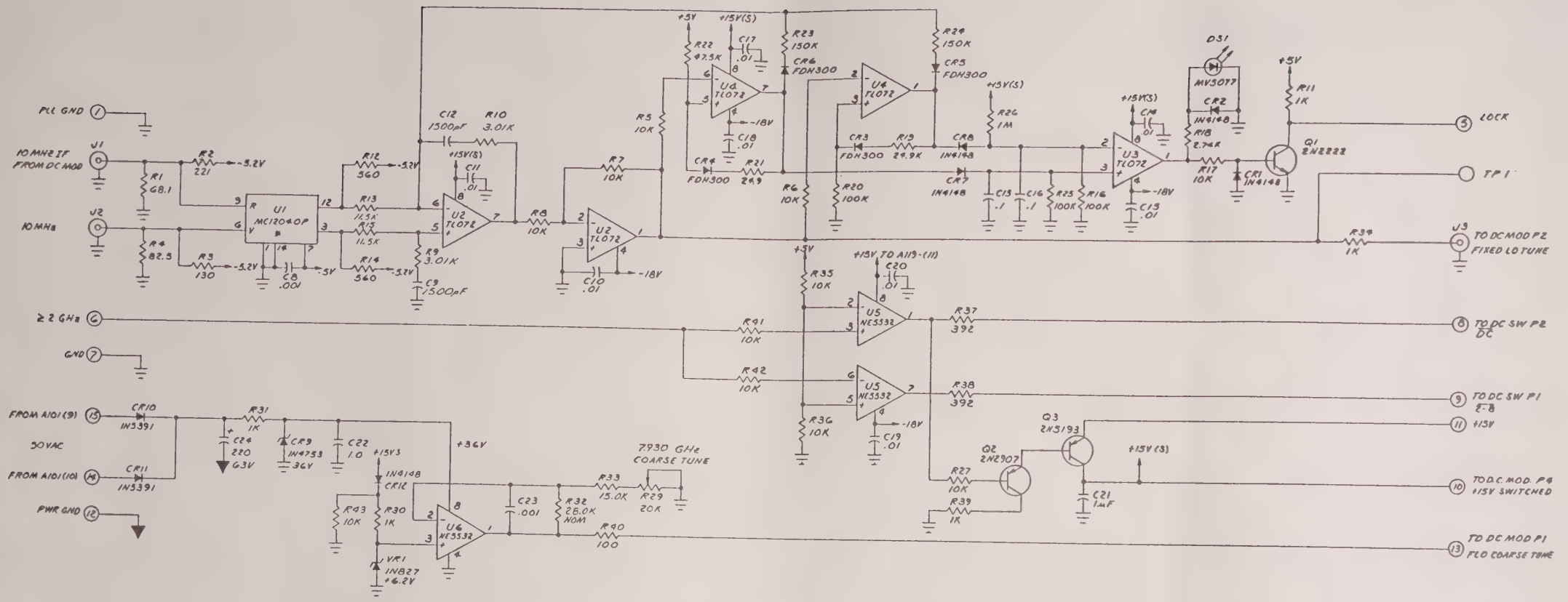
The computer controls the downconverter by means of this circuit, which supplies the necessary tuning signals and control lines.

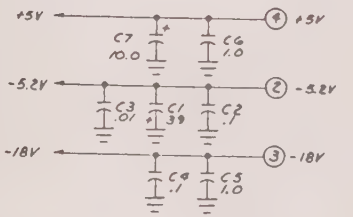
The ' > 2 GHz' logic line at pin 7 is used by inverter U5-16 to control the RF switch in the output path. In addition, the logic line (buffered by U5-15 and U5-14) controls (via Q2) the switched +15V power supply used by the downconverter module and by the PLL circuit on this board. During operation outside the .01-2 GHz band, the downconverter and its PLL circuit are disabled in order to prevent them from oscillating and contributing spurious frequencies to the RF output.

The downconverter module requires an adjustable power supply for coarse tuning of the 5.950 GHz local oscillator. The supply is nominally +26 volts, with an adjustment range of + 4 volts. The AC inputs at pins 13 and 14 come from the transformer secondaries and are rectified by CR9; a DC output of about +36 volts is furnished to the power supply pin of U6. The gain of the amplifier is adjusted by R29 in order to vary the output at pin 12 over an approximate range to +22 to +30 volts.

The IF from the downconverter module is produced by mixing the local oscillator's output with the 27th harmonic of the 220 MHz reference (i.e., 5.940 GHz). The IF is fed back to J1 and is equal to 10 MHz when the local oscillator is correctly tuned to 5.950 GHz. The phase comparator chip (U1) compares the IF to the 10 MHz timebase (J2) and produces wide pulses at one of its outputs (pins 3 or 12) depending on whether the IF is leading or lagging the timebase. The output pulses are averaged by a low pass filter circuit (see U2-7) to produce a DC tuning voltage. The tuning voltage is furnished (via J3) to the downconverter tuning input. The phase lock loop circuit adjusts the frequency in whichever direction will reduce the phase difference between the two 10 MHz inputs, until the local oscillator stabilizes at 5.950 GHz.

Because the signal fed back from the downconverter is generated by harmonic mixing, it is possible for the PLL circuit to become stuck at either extreme of its control range by pursuing the wrong intermediate frequency. To prevent the PLL from latching up in this way, two "kicker" circuits (U4-7 and U4-1) are used. The two amplifiers are set up as a window detector. If the output tuning voltage exceeds about 11 volts in either the positive or negative directions one of the amplifer outputs will forward-bias CR6 or CR5; the voltage fed back to U2-6 will drive the control voltage back towards zero to resume the search. In addition, the lock detector circuit (U3) monitors the control voltage; when this output exceeds the + 11 volt window, U3-1 goes high, the 'UNLOCK' LED is illuminated and the 'LOCK' output at pin 5 is pulled low.





NOTES: UNLESS OTHERWISE SPECIFIED
1) CAPACITOR VALUES ARE IN μF
2) RESISTOR VALUES ARE IN OHMS
3) ⊕ INDICATES HEAT SINK REQUIRED
4) ▼ INDICATES POWER GND

U #	TYPE	+5V	-5V	GND	+15V	115V S	-18V	36V
1	MC12040		7	1,14				
2	TL072					8	4	
3	TL072					8	4	
4	TL072					8	4	
5	NE5532				8		4	
6	NE5532			4				8

FIG: 7.A119.2
DOWNCONVERTER PLL PC ASSY (A119)
DWG# 304BM11600

REV D

OPTIONS

Option 03:

When this
100 kHz, 10
a remote co

Option 03 r
(A9) and
manual; the

Option 03: 1 kHz Resolution

When this option is installed, the output frequency resolution is 1 kHz. The 100 kHz, 10 kHz and 1 kHz digits may be set by the front panel switches or by a remote control command.

Option 03 requires the installation of two circuits: the Intermediate PLL (A9) and the High Resolution PLL (A10). These circuits are described in the manual; they are omitted from instruments without option 03.

Option 06: HIGH STABILITY TIME BASE

This option replaces the standard (10E-6/year) master reference oscillator (TCXO Assy 101BA09701) with a high stability time base (10E-9/day; part number 101CA20501).

Option 19: Reverse Power Protection

When this option is installed, a power limiter circuit is placed between the output of the step-attenuator and the RF output connector on the front panel. The limiter prevents excessive reverse power levels at the output connector from reaching the components in the instrument's RF path. An instrument with Option 19 installed will accept, without resulting damage, the following reverse power levels at the RF output connector: 5 W average power, 2 kW peak power (1 usec. pulse, .1% duty factor).

Option 22: Rear Panel RF Output

When this option is installed, the RF output connector is relocated to the instrument's rear panel.

SECTION NINE

SPECIAL CONFIGURATIONS

9.1 LOW FREQUENCY SYNTHESIS -- The Downconverter Circuit

Some instruments in the 610 series include the .01-2 GHz range, which is below the normal frequency range of YIG oscillators. In these instruments, a downconverter circuit is used to synthesize the .01-2 GHz range. The downconverter is a low frequency synthesizer which mixes the output of the instrument's YIG oscillator with the output of a local oscillator in order to produce an intermediate frequency in the desired range. The YIG and the local oscillator are both phase locked to the instrument's time base; performance specifications are not degraded in the downconverter range.

THEORY OF OPERATION

The downconverter circuit is interposed between the output of the RF module and the 10 dB step attenuator. During operation below 2 GHz, a switch in the output path diverts the RF output from the module to the downconverter; the low frequency synthesized by the downconverter is returned to the switch and furnished to the step attenuator. Most of the elements of the downconverter circuit are housed within a single module.

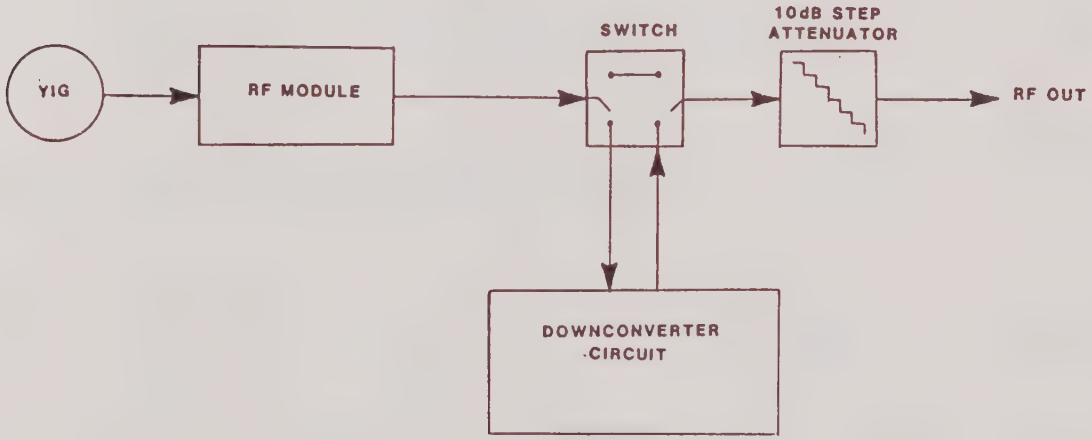


Fig. 9.1: The output path, as modified to include the downconverter.

The input from the RF module is attenuated (about -20 dB) and applied to the downconverter mixer, as the mixer's RF input. The RF input is required to be in the range of 5.960 to 7.950 GHz, and therefore the downconverter circuit can only be installed in instruments covering that range. The computer tunes the YIG oscillator appropriately for the desired RF input to the downconverter mixer. The RF is mixed with a fixed 5.950 GHz LO input. The local oscillator is phase-locked to the 10 MHz time base in order to maintain

5.950 GHz. The IF output from the mixer is equal to the difference between the RF and LO inputs (e.g., 1.000 GHz when the RF input is 6.950 GHz). The IF output is amplified (about +25 dB) and returned to the switch in the instrument's output path.

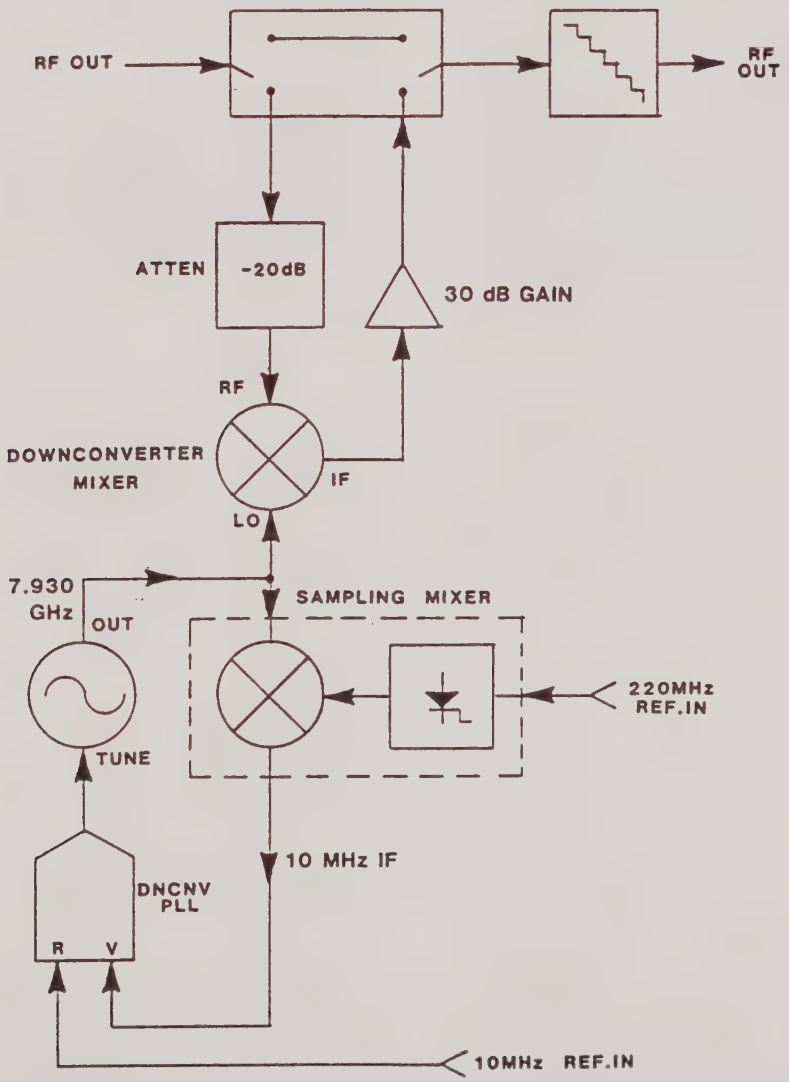


Fig. 9.2: The downconverter circuit.

The phase lock loop which controls the 5.950 GHz LO operates as follows. A sample of the LO frequency is applied to a sampling mixer (a mixer with a step-recovery diode multiplier on one input). The other input to the sampling mixer (the multiplier input) is the 220 MHz reference signal from the oscillator/multiplier circuit (PC board A113). The multiplier produces numerous harmonics of the 220 MHz reference; the 27th harmonic (5.940 GHz) combines with the 5.950 GHz LO to produce a 10 MHz intermediate frequency. This 10 MHz IF is fed back to the downconverter phase lock loop (PC board A119, which is mounted beside the downconverter module). The PLL circuit compares the 10 MHz IF to the 10 MHz timebase and fine-tunes the local oscillator in order to achieve and maintain phase lock.

Instrument functions, including level control and modulation, operate normally in the downconverter range. The frequency synthesis process is also normal, except that the YIG oscillator is tuned to a frequency that is 5.950 GHz higher than the actual output frequency.

CALIBRATION AND TESTING

The downconverter circuit includes one adjustment requiring calibration. To the calibration procedure in Section 4, add the following paragraph (as 3.4.1):

> Tie TP1 on the Downconverter PLL board (A119) to ground, disabling the loop. Set UUT for an output frequency of 1 GHz. Adjust R29 ('5.950 COARSE TUNE') for a frequency counter reading of 1.000 GHz, $\pm$ 5 MHz. Remove the ground jumper from TP1.

The performance verification procedure is not altered for instruments featuring the downconverter circuit, except that test frequencies in the .01-2 GHz range are included (see Test Data Sheet).

TROUBLESHOOTING

If the downconverter circuit is included in the instrument, the following considerations apply in troubleshooting:

1. Malfunctions occurring only during operation in the .01-2 GHz range point to the downconverter circuit. Check all power supplies, including the tuning power supply to the downconverter module.

2. A loss of RF power at any frequency may indicate that the RF switch added to the output path in downconverter-equipped units is set in the wrong position. A loss of RF power in the downconverter range may indicate failure of any of several elements of the downconverter circuit, including the 5.950 GHz oscillator, the amplifier, and either of the mixers. These devices are not readily accessible to maintenance in the field, but it may be possible to establish that a required power supply or reference signal is not reaching the downconverter module.

3. If the output frequency is unlocked, or is locked on the wrong frequency, the coarse tuning adjustment on the downconverter PLL

(circuit board A119) may be out of calibration. Also, verify that there is no loss of continuity between the PLL circuit and the downconverter module.

4. Level control and modulation in the .01-2 GHz range do not differ from operation at other frequencies. Signals for modulation and level correction are applied to the RF module and YIG oscillator rather than to the downconverter module and 5.950 GHz oscillator. Frequency synthesis in the .01-2 GHz range differs from normal operation only in that the YIG oscillator is tuned to a frequency equal to the RF output frequency plus 5.950 GHz.

PARTS LISTS AND DIAGRAMS

The components added to instruments featuring the .01-2 GHz range are shown in the parts lists and drawings appended to this section:

PAGE:	DESCRIPTION:
9-5	parts list, 2-8 freq. assembly w/downconverter
9-6	parts list, downconverter chassis
9-7, 9-8	parts list, downconverter PLL (A119)
9-9	fig. 9.3, freq. assembly w/downconverter
9-10	fig. 9.4, downconverter chassis assembly
9-11	fig. 9.5, downconverter chassis
9-12	fig. 9.6, dncnv PLL (A119), assy dwg & circuit descr.
9-13	fig. 9.7, dncnv PLL (A119), schematic

Parts List for FREQ .01-8 ASY No. 304CA08604 Rev. A

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	004BA13000	1	58900	004BA13000	2-8 MODULE, 600(M180)
2	MOYT-20208	1	24539	Y087-4198	2-8GHZ YIG XSTR OSC
3	MPBO-01303	1	28480	33322G-90	0-110DB 13GHZ PGM ATTEN
4	MDSO-00034	1	H0002	D2262-44	.01-34GHZ DETECTOR
5	304CA09802	1	58900	304CA09802	.085 CABLE #600B ASY
7	304CA09801	1	58900	304CA09801	.085 CABLE #600A ASY
8	JRAA-00200	1	98291	50-673-0159-31	SMA M TO SMA M ADAPT
9	RN55-00150	1	05905	SMA 0207 E 96	15 OHMS 1% MET FILM
10	RC20-00220	1	01121	EB-220-5	22 OHMS 5% 1/2W CARBON
11	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
14	RW25-00070	1	15915	TM25-7 OHM-1%Y	7 OHM 25W KELVIN LEAD
15	304AW08600	1	58900	304AW08600	M600 FREQ. 2-8 W/L

Parts List for M600 DWNCONV CHASSIS ASY No. 304CA11900 Rev. B

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
1	004DA25000	1	58900	004DA25000	M600 DOWNCONVERTER ASSY
2	304CA11600	1	58900	304CA11600	M600 DWNCONV. PLL PCA
3	004BA24000	1	58900	004BA24000	DOWNCONVERTER SW (M600)
4	304BA12100	1	58900	304BA12100	BUFFER MODULE PCA
5	304CA09803	1	58900	304CA09803	.085 CABLE #600G ASY
6	304CA09804	1	58900	304CA09804	.085 CABLE #600H ASY
7	304CA09805	1	58900	304CA09805	.085 CABLE #600J ASY
8	304CA09806	1	58900	304CA09806	.085 CABLE #600K ASY
9	304CA09807	1	58900	304CA09807	.085 CABLE #600L ASY
10	HIGP-00090	2	95987	WG201	FLEXIBLE GROMMET
11	304CA09808	1	58900	304CA09808	.085 CABLE #600M ASY
12	MPFS-01806	1	64671	18A-6	6DB SMA M/F PAD
13	304CF12500	1	58900	304CF12500	DOWN CONV. MOUNT

Parts List for M600 DWNCONV. PLL PCA No. 304CA11600 Rev. D

Item		Part Number	Qty	FSCM	Mfr's Part Number	Description
	1	304CF11600	1	58900	304CF11600	M600 DWNCONV. PLL PCB
	2	ETSB-06216	15	88245	2000B	BIFURCATED TERMINAL 5/32
	3	ETST-06224	1	88245	1280B	TURRET TERMINAL
C	1	CT10-06390	1	56289	150D396X9010B2	39 UF 10V TANTALUM
C	2	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	3	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	4	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	5	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	6	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	7	CT20-06100	1	56289	150D106X9020B2	10 UF 20V TANTALUM
C	8	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	9	CC50-02150	1	51642	200-050-NP0-152J	1500PF CERAMIC NP0
C	10	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	11	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	12	CC50-02150	1	51642	200-050-NP0-152J	1500PF CERAMIC NP0
C	13	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	14	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	15	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	16	CC50-04100	1	56289	2CZ5U104X0050C4	.1 UF CERAMIC Z5U
C	17	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	18	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	19	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	20	CC50-03100	1	51642	150-100-W5R-103K	.01 UF CERAMIC X7R
C	21	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	22	CC50-05100	1	56289	3CZ5U105X0050C5	1 UF CERAMIC Z5U
C	23	CC50-02100	1	52763	EDPT-1000-Y5P10%	.001 UF CERAMIC Y5P
C	24	CE63-07220	1	56289	501D227F063PR	220 UF 63V ELECT.
CR	1	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	2	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	3	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
CR	4	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
CR	5	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
CR	6	DSA0-00300	1	07263	FDH300	FDH300 LOW LEAK DIODE
CR	7	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	8	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
CR	9	DZAD-04753	1	04713	1N4753	IN4753 36 V ZENER
CR	10	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
CR	11	DPAB-05391	1	04713	1N5391	IN5391 1.5A 35V DIODE
CR	12	DSA0-04148	1	07263	1N4148	IN4148 G.P. DIODE
DS	1	ILRR-00125	1	58361	MV5077C	RED LED 1/8" DIA
J	1	JRBM-00101	1	98291	51-053-0000	SMB M RTANG PC MOUNT
J	2	JRBM-00101	1	98291	51-053-0000	SMB M RTANG PC MOUNT
J	3	JRBM-00101	1	98291	51-053-0000	SMB M RTANG PC MOUNT
Q	1	QBNS-02222	1	27014	PN2222	PN2222 .5A 30V NPN
Q	2	QBPS-02907	1	27014	PN2907	PN2907 .5A 40V .6W PNP
Q	3	QBPP-05193	1	04713	2N5193	2N5193 4A 40V 40W PNP
R	1	RN55-00681	1	05905	SMA 0207 E 96	68.1 OHMS 1% MET FILM
R	2	RN55-02210	1	05905	SMA 0207 E 96	221 OHMS 1% MET FILM
R	3	RN55-01300	1	05905	SMA 0207 E 96	130 OHMS 1% MET FILM
R	4	RN55-00825	1	05905	SMA 0207 E 96	82.5 OHMS 1% MET FILM
R	5	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM

Parts List for M600 DWNCONV. PLL PCA No. 304CA11600 Rev. D

Item	Part Number	Qty	FSCM	Mfr's Part Number	Description
R 6	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 7	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 8	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 9	RN55-13010	1	05905	SMA 0207 E 96	3.01 K OHMS 1% MET FILM
R 10	RN55-13010	1	05905	SMA 0207 E 96	3.01 K OHMS 1% MET FILM
R 11	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 12	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 13	RN55-21150	1	05905	SMA 0207 E 96	11.5 K OHMS 1% MET FILM
R 14	RN55-05620	1	05905	SMA 0207 E 96	562 OHMS 1% MET FILM
R 15	RN55-21150	1	05905	SMA 0207 E 96	11.5 K OHMS 1% MET FILM
R 16	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 17	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 18	RN55-12740	1	05905	SMA 0207 E 96	2.74 K OHMS 1% MET FILM
R 19	RN55-22490	1	05905	SMA 0207 E 96	24.9 K OHMS 1% MET FILM
R 20	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 21	RN55-22490	1	05905	SMA 0207 E 96	24.9 K OHMS 1% MET FILM
R 22	RN55-24750	1	05905	SMA 0207 E 96	47.5 K OHMS 1% MET FILM
R 23	RN55-31500	1	05905	SMA 0207 E 96	150 K OHMS 1% MET FILM
R 24	RN55-31500	1	05905	SMA 0207 E 96	150 K OHMS 1% MET FILM
R 25	RN55-31000	1	05905	SMA 0207 E 96	100 K OHMS 1% MET FILM
R 26	RN55-41000	1	05905	SMA 0207 E 96	1 M OHMS 1% MET FILM
R 27	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 29	RAPF-22000	1	73138	66WR20K	20K 10% 20T VERT PC
R 30	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 31	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 32	RN55-22800	1	05905	SMA 0207 E 96	28 K OHMS 1% MET FILM
R 33	RN55-21500	1	05905	SMA 0207 E 96	15 K OHMS 1% MET FILM
R 34	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 35	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 36	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 37	RN55-03920	1	05905	SMA 0207 E 96	392 OHMS 1% MET FILM
R 38	RN55-03920	1	05905	SMA 0207 E 96	392 OHMS 1% MET FILM
R 39	RN55-11000	1	05905	SMA 0207 E 96	1 K OHMS 1% MET FILM
R 40	RN55-01000	1	05905	SMA 0207 E 96	100 OHMS 1% MET FILM
R 41	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 42	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
R 43	RN55-21000	1	05905	SMA 0207 E 96	10 K OHMS 1% MET FILM
U 1	UENO-12040	1	04713	MC12040P	MC12040P PHASE/FREQ DET
U 2	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 3	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 4	UONO-00072	1	01295	TL072CP	TL072CP DUAL FET OP AMP
U 5	UONO-05532	1	18324	NE5532N	DUAL;OP AMP;10MHz
U 6	UONO-05532	1	18324	NE5532N	DUAL;OP AMP;10MHz
VR 1	DRAE-00827	1	04713	1N827	IN827 6.2V REF. DIODE

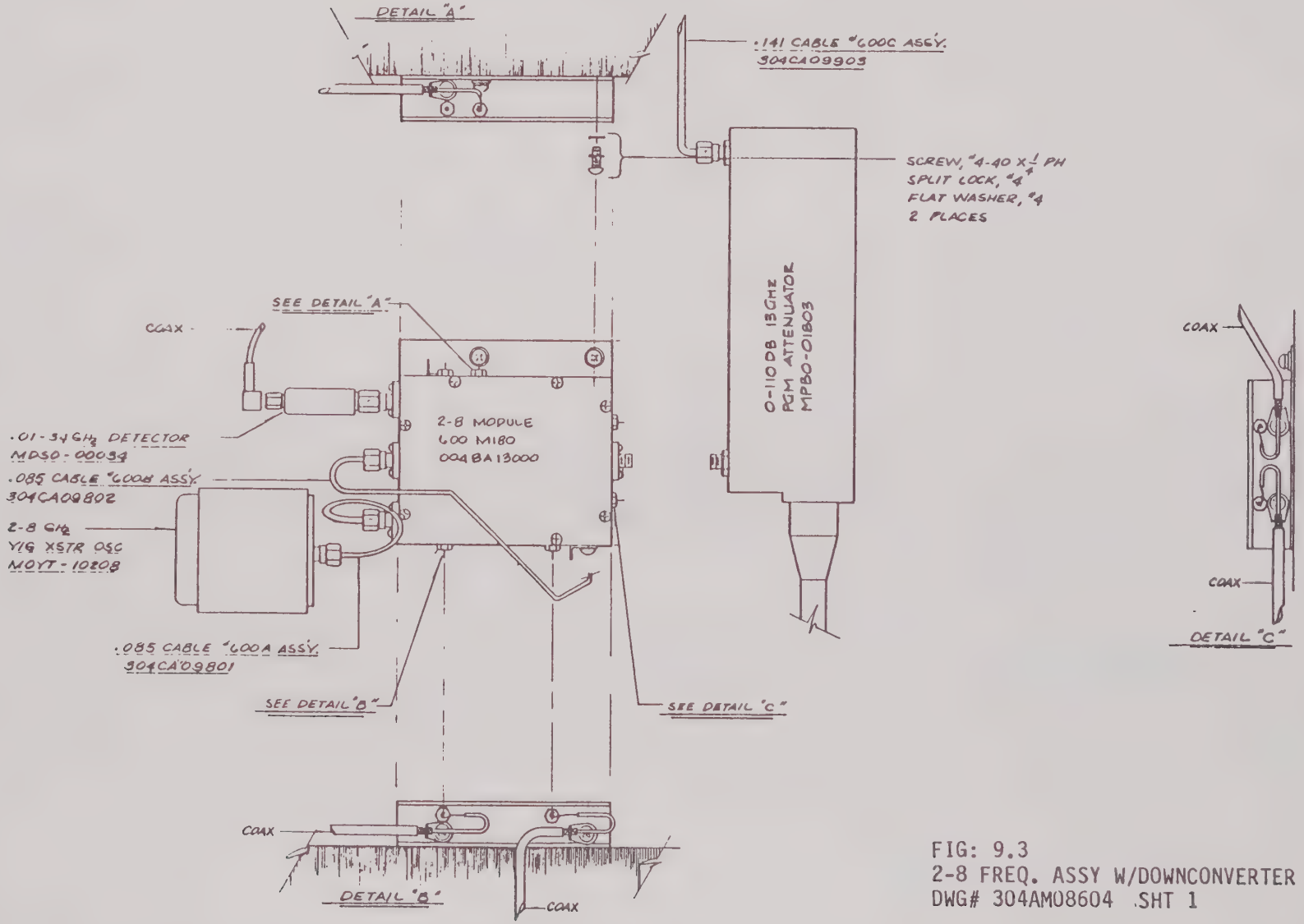


FIG: 9.3
2-8 FREQ. ASSY W/DOWNCONVERTER
DWG# 304AM08604 .SHT 1

REV A

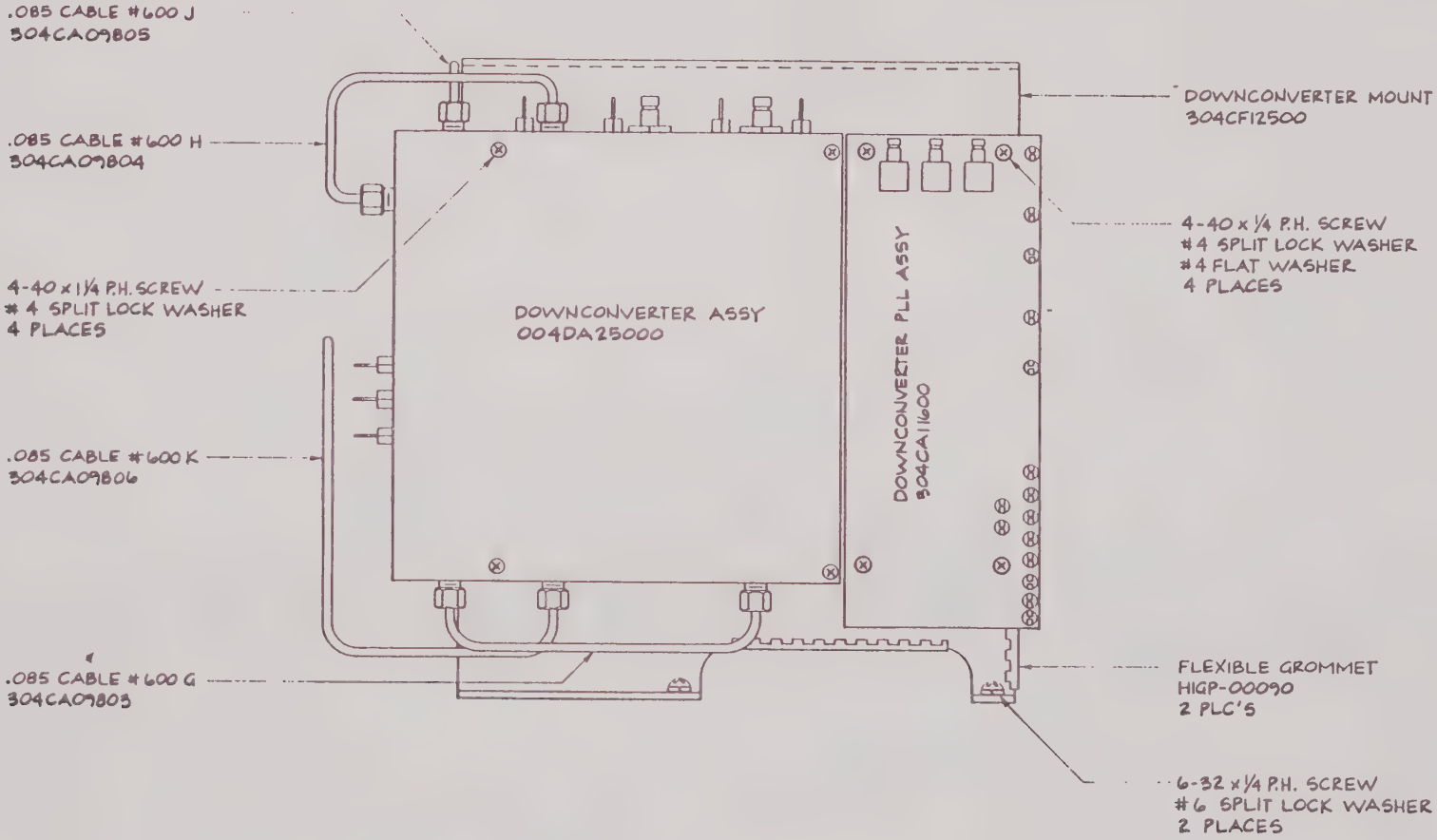


FIG: 9.4
DOWNCONVERTER CHASSIS
DWG# 304CA11900 SHT 1

REV B

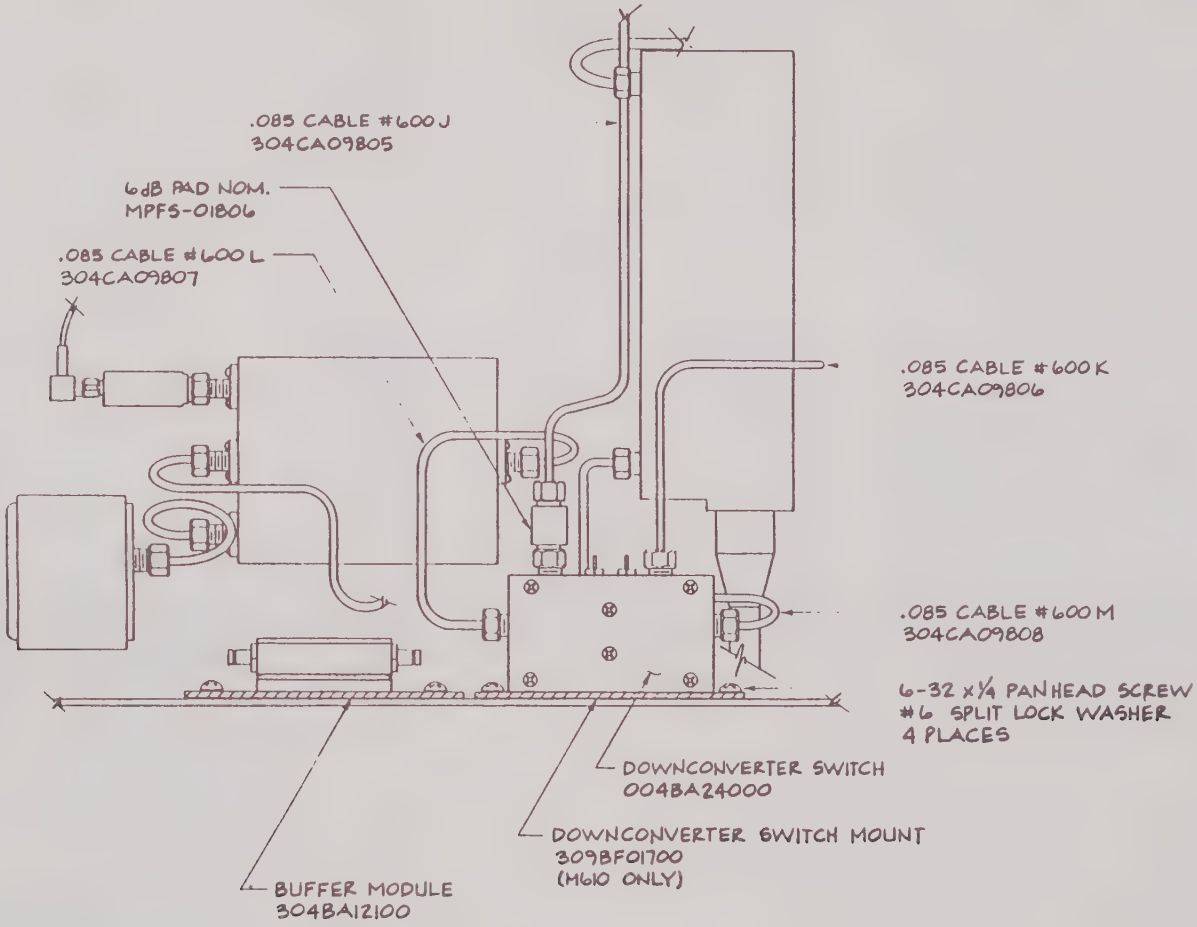


FIG: 9.5
DOWNCONVERTER CHASSIS
DWG# 304CA11900 SHT 2

REV B

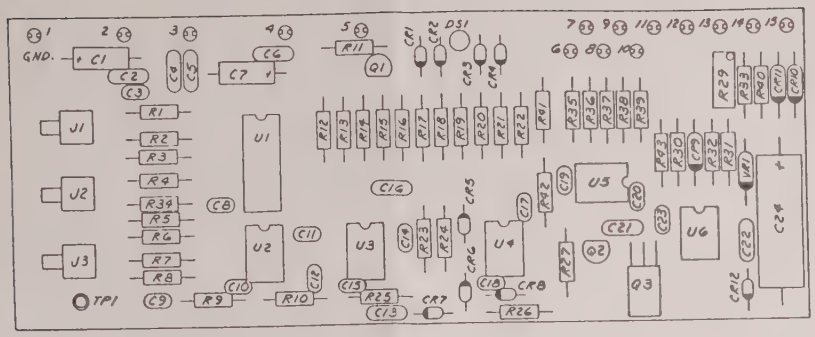


FIG: 9.6
DOWNCONVERTER PLL PC ASSY (A119)
DWG# 304BM11600 SHT 1

REV D

DOWNCONVERTER PHASE LOCK LOOP -- PC Board A119

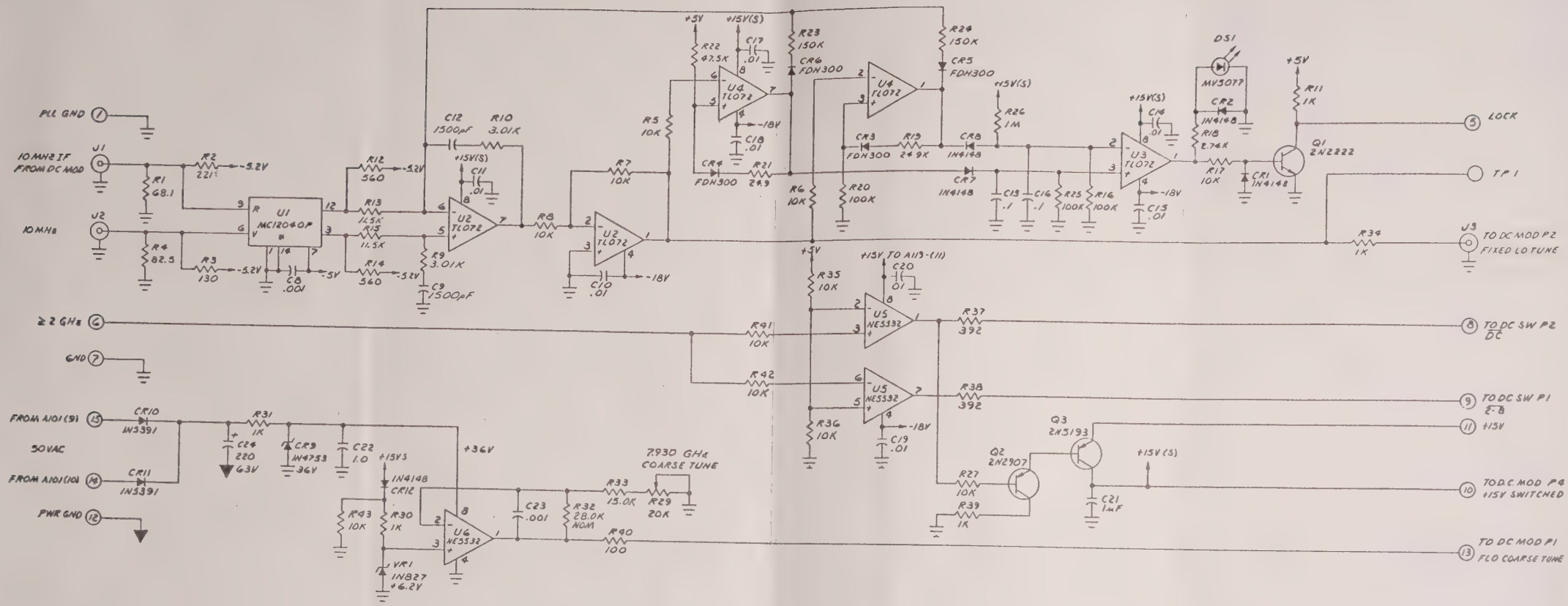
The computer controls the downconverter by means of this circuit, which supplies the necessary tuning signals and control lines.

The ' > 2 GHz' logic line at pin 7 is used by inverter U5-16 to control the RF switch in the output path. In addition, the logic line (buffered by U5-15 and U5-14) controls (via Q2) the switched +15V power supply used by the downconverter module and by the PLL circuit on this board. During operation outside the .01-2 GHz band, the downconverter and its PLL circuit are disabled in order to prevent them from oscillating and contributing spurious frequencies to the RF output.

The downconverter module requires an adjustable power supply for coarse tuning of the 5.950 GHz local oscillator. The supply is nominally +26 volts, with an adjustment range of $\pm$ 4 volts. The AC inputs at pins 13 and 14 come from the transformer secondaries and are rectified by CR9; a DC output of about +36 volts is furnished to the power supply pin of U6. The gain of the amplifier is adjusted by R29 in order to vary the output at pin 12 over an approximate range to +22 to +30 volts.

The IF from the downconverter module is produced by mixing the local oscillator's output with the 27th harmonic of the 220 MHz reference (i.e., 5.940 GHz). The IF is fed back to J1 and is equal to 10 MHz when the local oscillator is correctly tuned to 5.950 GHz. The phase comparator chip (U1) compares the IF to the 10 MHz timebase (J2) and produces wide pulses at one of its outputs (pins 3 or 12) depending on whether the IF is leading or lagging the timebase. The output pulses are averaged by a low pass filter circuit (see U2-7) to produce a DC tuning voltage. The tuning voltage is furnished (via J3) to the downconverter tuning input. The phase lock loop circuit adjusts the frequency in whichever direction will reduce the phase difference between the two 10 MHz inputs, until the local oscillator stabilizes at 5.950 GHz.

Because the signal fed back from the downconverter is generated by harmonic mixing, it is possible for the PLL circuit to become stuck at either extreme of its control range by pursuing the wrong intermediate frequency. To prevent the PLL from latching up in this way, two "kicker" circuits (U4-7 and U4-1) are used. The two amplifiers are set up as a window detector. If the output tuning voltage exceeds about 11 volts in either the positive or negative directions one of the amplifer outputs will forward-bias CR6 or CR5; the voltage fed back to U2-6 will drive the control voltage back towards zero to resume the search. In addition, the lock detector circuit (U3) monitors the control voltage; when this output exceeds the $\pm$ 11 volt window, U3-1 goes high, the 'UNLOCK' LED is illuminated and the 'LOCK' output at pin 5 is pulled low.



NOTES: UNLESS OTHERWISE SPECIFIED
1.) CAPACITOR VALUES ARE IN μF
2.) RESISTOR VALUES ARE IN OHMS
3.) ⊕ INDICATES HEAT SINK REQUIRED
4.) ▼ INDICATES POWER GND

U #	TYPE	+5V	-5V	GND	+15V	115VS	-18V	+36V
1	MC12040		7	1,14				
2	TL072					8	4	
3	TL072					8	4	
4	TL072					8	4	
5	NE5532				8		4	
6	NE5532			4				8

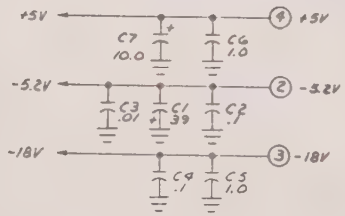


FIG: 9.7
DOWNCONVERTER PLL PC ASSY (A119)
DWG# 304BM11600 SHT 2

REV D

9.2 SPECIAL CONFIGURATIONS

If the instrument is specially configured (as indicated by a three-digit number on the "Config." line of the Model/Serial/Config. sticker), a supplement describing the configuration is added to the manual, beginning on the following page. Modifications of the instrument, its circuits, and its performance characteristics are listed in that supplement.

MODEL 610/.01-8, CONFIGURATION 117

Model 610/.01-8, Configuration 117 includes a standard Model 610 signal generator, with the following modifications:

Two front panel BNC connectors ('SWEEP SYNC TRIG IN' and 'SWEEP OUT') are duplicated on the rear panel. Either the front panel or the rear panel connector may be used for each.

The frequency range is 10 MHz to 8 GHz. The .01-2 GHz range is made possible by installation of the downconverter (see section 9.1).

Performance characteristics are modified, as described in the specifications on the following pages.

PERFORMANCE SPECIFICATIONS

Model 610/.01-8, Configuration 117

1.0 FREQUENCY CHARACTERISTICS

1.1 Frequency Range: 10MHz to 8GHz

1.2 Frequency Resolution: 1kHz

1.3 Settable Frequencies: CW frequencies,
Start frequency (F1),
Stop frequency (F2),
Center frequency (CF),
Sweep width (F),
and all markers (M1 through M5 via the front panel, M1 through M8 via the GPIB) are settable within the frequency range and resolution of the instrument

1.3.1 Frequency Setting Method: Lever switch/"enable" push-button, "up/down" push buttons or the GPIB

1.4 Sweep Operation

1.4.1 Analog (Continuous) Sweep: All function, mode and sweep time parameters are selectable via front panel push buttons or the GPIB

1.4.1.1 Sweep Functions: Automatic recycle, single sweep or triggered single sweep

1.4.1.1.1 Sweep Reset: Resets to start of sweep (any function)

1.4.1.2 Sweep Modes

1.4.1.2.1 Start/Stop: Sweeps upward from preset start frequency (F1) to preset stop frequency (F2)

1.4.1.2.1.1 Range: $0.01GHz \leq F1 < F2 \leq 8GHz$

1.4.1.2.2 CF: Sweeps upward through preset sweep width (F) centered symetrically about a preset center frequency (CF)

1.4.1.2.2.1 Range: $0.01GHz \leq (CF-(F/2)) < (CF+(F/2)) \leq 8GHz$

1.4.1.2.3 M: Sweeps upward from preset marker (M1) to preset marker (M3)

1.4.1.2.3.1 Range: $0.01GHz \leq M1 < M3 \leq 8GHz$

1.4.1.3 Sweep Time: Selectable from approximately 10msec to 100sec

1.4.1.3.1 Maximum Sweep Rate: 600MHz/msec

1.4.1.3.2 Band Crossing Deadtime (At approximately 2GHz): Approximately 50 msec

1.4.1.4 Sweep Accuracy (First and last frequency, any mode): ± 30MHz

1.4.1.5 Sweep Linearity (After first 100usec, any sweep time or mode): ± 5MHz

1.4.1.6 Sweep Resolution (Any mode): Approximately 2MHz for sweep widths >524MHz; approx. 128kHz for sweep widths <524 MHz

1.4.1.7 Proportional Output: Analog signal directly proportional to frequency (0.5V/GHz); BNC connector, rear panel

1.4.2 Digital (Step) Sweep: All function, mode, step size, sweep time and sweep direction parameters are selectable via front panel push buttons or the GPIB

1.4.2.1 Sweep Functions: Automatic recycle, single sweep, triggered single sweep or single step

1.4.2.1.1 Sweep Stop: Stops sweep (any function)

1.4.2.1.2 Sweep Reset: Resets to start of sweep (any function)

1.4.2.2 Sweep Modes

1.4.2.2.1 Start/Stop: Sweeps between two preset frequencies (F1 and F2)

1.4.2.2.1.1 Range: 0.01GHz ≤ F1 < F2 ≤ 8GHz

1.4.2.2.1.2 Sweep Direction: Upward (F1 to F2) or downward (F2 to F1)

1.4.2.2.2 CF: Sweeps through a preset sweep width (F) centered symetrically about a preset center frequency (CF)

1.4.2.2.2.1 Range: 0.01GH ≤ (CF-(F/2)) < (CF+(F/2)) ≤ 8GHz

1.4.2.2.2.2 Sweep Direction: Upward (CF-(F/2) to CF +(F/2)) or downward (CF+(F/2) to CF-(F/2))

1.4.2.2.3 M: Sweeps between two preset markers (M1 and M3)

1.4.2.2.3.1 Range: 0.01GHz ≤ M1 < M3 ≤ 8GHz

1.4.2.2.3.2 Sweep Direction: Upward (M1 to M3) or downward (M3 to M1)

1.4.2.3 Step Size (Any mode): 1, 10, 100kHz; 1, 10, 100MHz or 1GHz

1.4.2.4 Sweep time (Any mode): Selectable, 10msec/step to 100sec/step

1.4.3 Sweep Trigger Input: TTL low to initiate single sweep (single step, when "stop" control activated in digital (step) sweep) BNC connector, rear panel and front panel

1.4.4 Marker/Blanking Output: Composite signal for Z-axis modulation of an oscilloscope. Levels are: dark = +5V,
marker "on" = -5V
unblanking = 0V
BNC connector, rear panel and front panel

1.4.5 Ramp Output: 0 to +10V, proportional to frequency between sweep limits (any mode); BNC connector, rear panel

1.4.6 Display M3-M1: Displays frequency difference between markers (M3-M1). Selectable via front panel pushbutton or the GPIB

1.5 CW Operation

1.5.1 Accuracy: Same as time base

1.5.2 Stability: Same as time base

1.5.3 Time Base

1.5.3.1 Internal

1.5.3.1.1 Frequency: 10MHz

1.5.3.1.2 Aging Rate: $<1 \times 10^{-6}$/year after 20 min warm-up

1.5.3.2 External: 10MHz $\pm$ 1×10^{-6} or better, 1.5V, p-p overrides internal time base

1.5.3.3 Time Base Output: Buffered 10MHz, 2V, p-p, into 50 ohms, derived from internal or external time base

1.5.4 Switching Time (within 1kHz of selected frequency): <125msec

2.0 SPECTRAL PURITY

2.1 Harmonics, Subharmonics: <-40dBc at RF frequencies> $\geq$ 2GHz, <-30dBc at RF frequencies <2GHz

2.2 Spurious (Nonharmonics): <-55dBc at RF frequencies $\geq$ 2GHz, <-50dBc at RF frequencies <2GHz

2.3 SSB Phase Noise (1Hz BW, CW operation): <-75dBc at 10kHz offset from carrier

3.0 RF OUTPUT CHARACTERISTICS

3.1 Range: +10 to -110dBm, 1.5 to 8GHz; +13.6 to -110dBm, .010 to 1.5GHz

3.2 Resolution: 0.1dB

3.3 Accuracy: ± 2dB

3.4 Flatness (Any output level): ± 2dB

3.5 Output Impedance: 50ohms, nominal

3.6 Source SWR: <2:1

3.7 Output Connector: Type N

3.8 External ALC: Negative detector, gain and offset adjustments provided

3.9 RF off: Turns RF output "off". Selectable via front panel pushbutton or the GPIB

4.0 MODULATION CHARACTERISTICS

4.1 Pulse Modulation (PM): Selectable via front panel or the GPIB

4.1.1 External

4.1.1.1 Repetition Rate: 10Hz to 1MHz

4.1.1.2 Pulse Width: ≥ 100nsec

4.1.1.3 Input Required: TTL level signal. Positive level = RF "on"

4.1.1.4 Input Connector: Type BNC, front panel

4.1.2 Internal: Fixed square wave, 1kHz rate

4.1.3 On/Off Ratio: ≥ 80dB

4.1.4 Rise/Fall Times: <25nsec

4.1.5 Overshoot, Undershoot and Ringing: ± 2dB

4.1.6 Settling Time (To within ± 1dB): ≤ 100nsec

4.2 Amplitude Modulation (AM): Selectable via front panel or the GPIB

4.2.1 External

4.2.1.1 Rate: 10Hz to 100kHz, 3dB points referenced to 1kHz, sine wave

4.2.1.2 Sensitivity: 1V, p-p, for 50% modulation at 1kHz rate

4.2.1.3 Input Impedance: 600ohms, nominal, AC coupled

4.2.1.4 Input Connector: Type BNC, front panel

4.2.1.5 Distortion: $\leq$ 5% at 50% depth and 1kHz rate

4.2.2 Internal: Fixed sine wave, 1kHz rate

4.2.3 Depth: 0 to $\geq$ 82% (0 to $\geq$ 20dB)

4.2.4 AM Depth Indicator: 3 digits

4.2.4.1 Resolution: 0.1%

4.2.4.2 Accuracy: $\pm$ 10% of actual modulation depth at 50% modulation, 1kHz rate

4.3 Frequency Modulation (FM): Selectable via front panel or the GPIB

4.3.1 External

4.3.1.1 Rate: 10Hz to 1MHz

4.3.1.2 Sensitivity: $\pm$ 1V, peak, for maximum deviation

4.3.1.3 Input Impedance: 50 ohms, nominal

4.3.1.4 Imput Connector: Type BNC, front panel

4.3.1.5 Distortion: $\leq$ 5% at maximum deviation and 500kHz rate

4.3.2 Internal: Fixed triangle wave, 1kHz rate

4.3.3 Deviation: $\pm$ 5MHz, peak

4.3.4 FM Deviation Indicator: 3 digits

4.3.4.1 Resolution: 10kHz

4.3.4.2 Accuracy: $\pm$ 10% of actual deviation at 3MHz, peak deviation and 100kHz rate

5.0 STORE/RECALL: Store and recall front panel set-ups via front panel push button or the GPIB

5.1 Information Stored: All CW, sweep and output power parameters

5.2 Storage Capacity: One to nine complete front panel set-ups

5.3 Memory Type: Non-Volatile

6.0 GENERAL CHARACTERISTICS

6.1 GPIB: IEEE STD 488-1978, all front panel controls and readouts except power on/off and modulation vernier controls. These subsets are implemented: SH1, AH1, T6, L4, RL1, SR1, DT1, DC1 and C0

6.2 Operating Temperature Range: 0 to +50°C

6.3 Warm-up Time: 20 minutes, max

6.4 Power Required: 115VAC ± 10%, 60-400Hz ± 5%

SECTION TEN

MANUAL CHANGES

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